Update on Our Journey with the PI System at DCP Midstream

Joe Hill – PI System Development Lead

Our Story

- DCP Midstream at a Glance
- Our Journey with the PI System
- PI System –Integration, applications & Analytics Infrastructure

Areas of Presentation Focus

- Accomplishments since PI World 2018
- New Use Case Examples
- Priorities for 2019

DCP Midstream - Who We Are

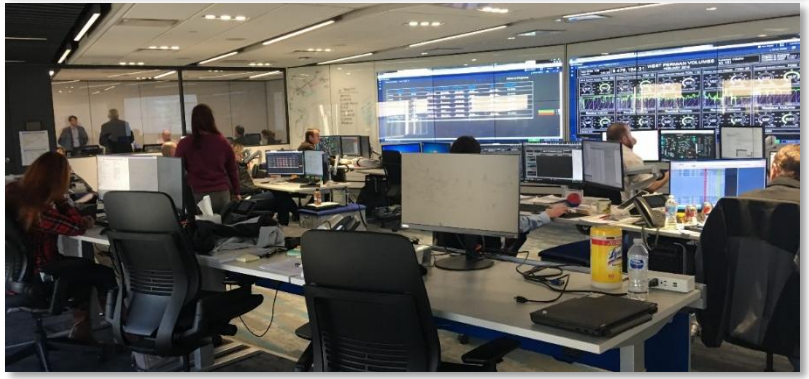
- **We provide the full range of midstream services**
  - Gas gathering, compression, treating, and processing
  - Natural gas liquid (NGL) production and fractionation
  - Condensate recovery
  - Transportation, storage and sale of residue gas, NGL and propane
- **One of the largest U.S. natural gas processing companies**
- **One of the largest U.S. producers of NGLs**
- **One of the largest NGL pipeline operators**

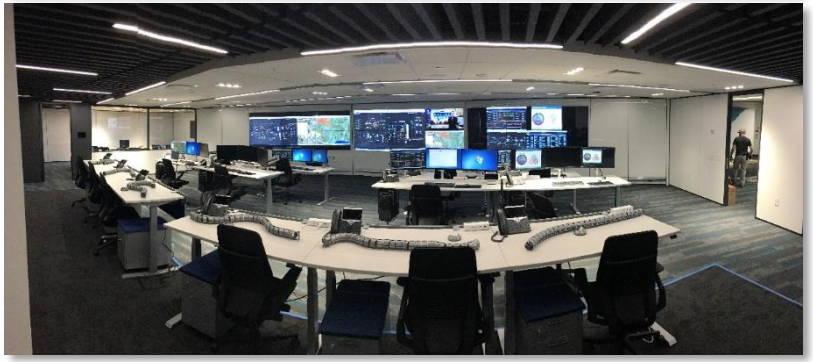
Fast Facts

- **63 Operating Gas Plants**
- **11 Operating Frac Plants**
- **57,000 Miles of gathering PL**
- **>400 Booster Stations**
- **1400+ Compression Units**
- **1M+ gathering system HP**
- **>42,000 meters**
- **>500K BPD NGL capacity**
- **4,500 miles NGL PL**

The Integrated Collaboration Center (ICC)

Transformation – People, Processes, Technology





Our Journey with the PI System

2017

Q1

Construction Begins for new ICC

Initial ICC begins
4 Gas Plants on-boarded in ICC

EA Kick Off Meeting & PI AF Jump start/SME training
Rapid Rollout of PI System Infrastructure

Q2

ICC moved to 23rd Floor in Denver HQ

1st ICC Coordinator hired

Q3

1st Full Regional Rollout

Q4

First of Month (FOM) Targeting Alignment coordination begins from ICC

2018

Q1

Began Integrated Engineering support

Q2

6 ICC Coordinators driving integrated decisions

35 Total Gas Plants & 5 Frac Plants supported by the ICC

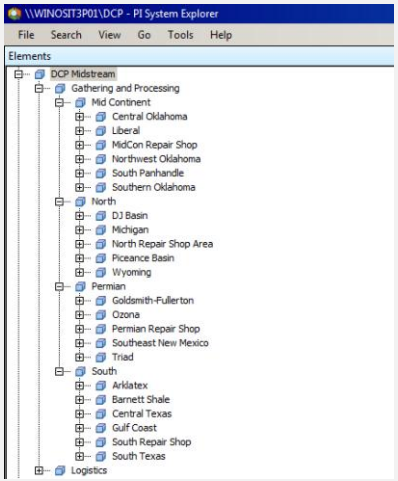
Begin Gas Control Standup

60 Gas & 11 Frac Plants supported by the ICC

2019

DCP Midstream PI System Development

Building the Tools for Reliability



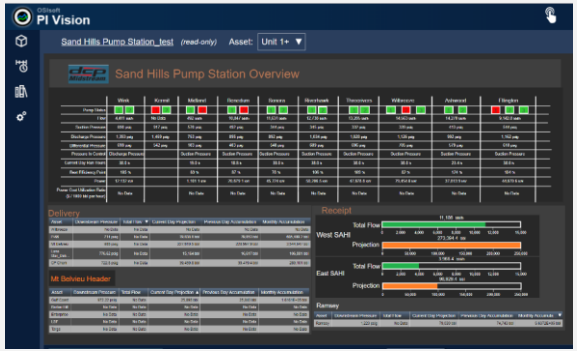
PI Asset Framework (PI AF)

Develop Hierarchy of Gas Plant, Compressor Station, Pipeline Assets

Organization of Data Into Useful Sets

Templates for Scalability

Translation/Integration With Other Business Systems



PI Vision

Dashboards for Operational Monitoring

Multiple Sources of Data Combined Into Single View

Pair Analytics w/Real-Time Values

Single Point Access Across Organization

From: PINotifications@dcpmidstream.com [mailto:PINotifications@dcpmidstream.com]
Sent: Monday, October 09, 2017 2:40 AM
To: Babb, Joshua D
Subject: Engine Cylinder Temp Deviation on C193 at Wells Ranch (2017-10-09 02:35) generated a new notification event.

Event: Engine Cylinder Temp Deviation on C193 at Wells Ranch (2017-10-09 02:35)
Name: Engine Cylinder Health
Server: WINOSIT3T01
Database: DCP Midstream
Start Time: 10/9/2017 2:35:00 AM Mountain Daylight Time (GMT-06:00:00)
Target: DCP Midstream\Gathering and Processing\North\DJ Basin\Weld County Super\Weld Gathering\Wells Ranch\C193\Engine
Severity: None
Send Time: 10/9/2017 2:40:06 AM Mountain Daylight Time (GMT-06:00:00)

Please reference the table below for Cylinder Temperatures that triggered this notification:

Cylinder	Temperature at Notification (°F)	Offset (°F)
1 L	1337.30004882813	0
1 R	1339	0
2 L	1349.19995117188	0
2 R	1350.30004882813	0
3 L	1356	0
3 R	1340.69995117188	0
4 L	1346.5	0
4 R	1354.90002441406	0
5 L	2498	-1200
5 R	1342	0
6 L	839.200012207031	75
6 R	1315.69995117188	0

PI Alerts & PI Notification

24/7 Monitoring & Communication of Anomalies

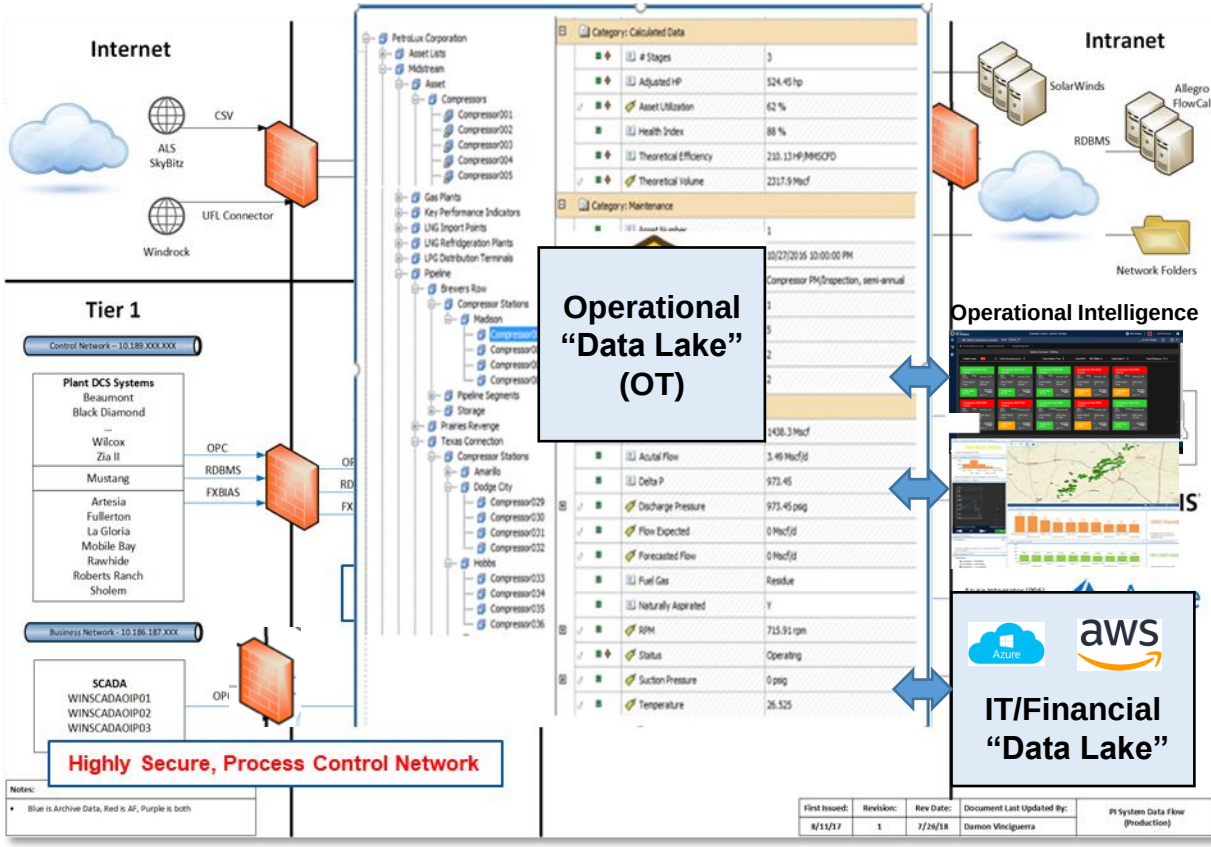
Failure Detection, Efficiency Monitoring, Work Mgmt.

Improve Operational Awareness

Eliminate “Digging” for Issues

Example of an OT Data Integration Infrastructure

- **Plant DCS** (OPC, RDBMS, FXBAIS)
- **Wonderware SCADA** (OPC, RDBMS)
- **Allegro** – Market Prices (RDBMS)
- **Windrock Spotlight** (Connector for UFL)
- **VMGSim** (OPC – bidirectional data flow)
- **ACI Compression Modeling** (custom utility – bidirectional data flow)
- **Current local temperature** (custom utility)
- **FlowCal** - Volumes and GC (RDBMS)
- **SkyBitz** – remote tank monitoring (UFL)
- **ALS** – lab tests of oil samples (UFL)
- **SolarWinds** – network equipment status (Connector for UFL)
- **FieldSquared** – Operator rounds (custom utility and UFL)



Reference: DCP Midstream's PI World 2018 Presentation

Templates, Templates, Templates

Configured via Agile Method by the SMEs with Governance

Elements

- Templates: 408
- Instances: 11,898
- **29 times as many instances as templates**

Analysis

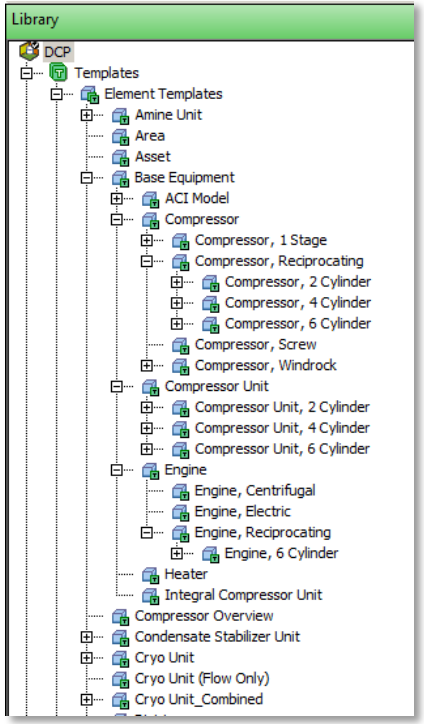
- Templates: 807
- Instances: 84,020
- **104 times as many instances as templates**

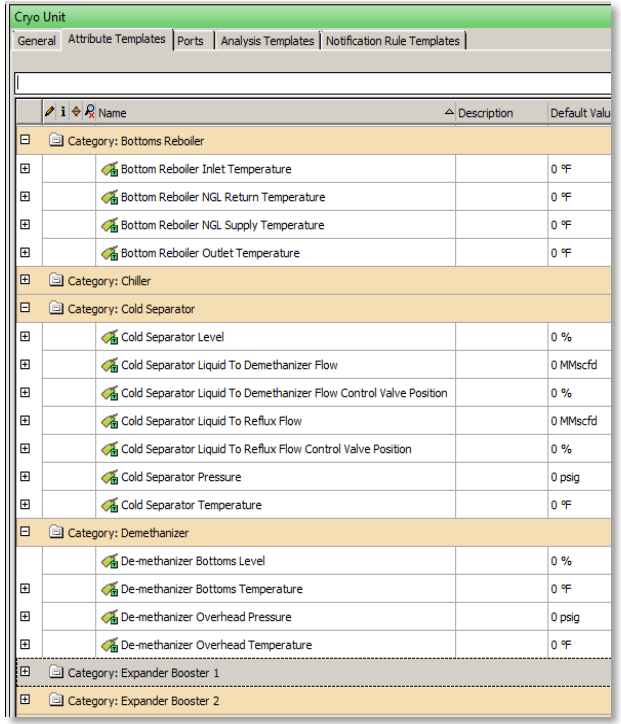
Notifications

- Templates: 109
- Instances: 42,336
- **388 times as many instances as templates**

Event Frames Generated

- **1,331,017**





The Smart Gas Plant – “Layers of Analytics”

The PI System as an Operational Analytics Infrastructure

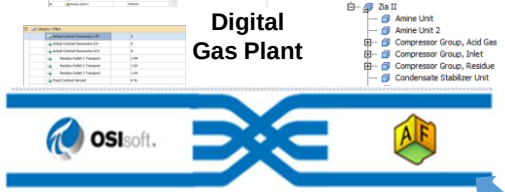
- End to end view of plant
- Operational and financial targets
- PvA calculations

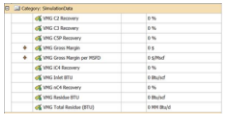
Physical Gas Plant

“real-time/streaming Calculations & Analytics”

OPC Client Link

Digital Gas Plant



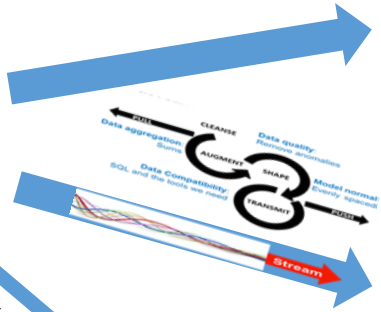


Gas Plant asset configurable templates

PI AF Linked Table

Financial Table

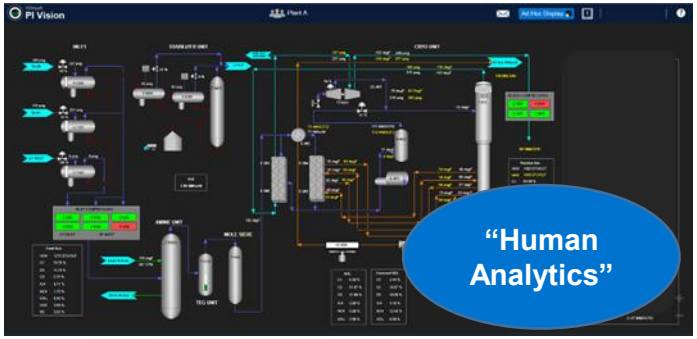
Optimization Model



PI AF Linked Table

- Real-time Commodity Pricing
- Financials based on contract mix

Gas Plant Visualization including mobile



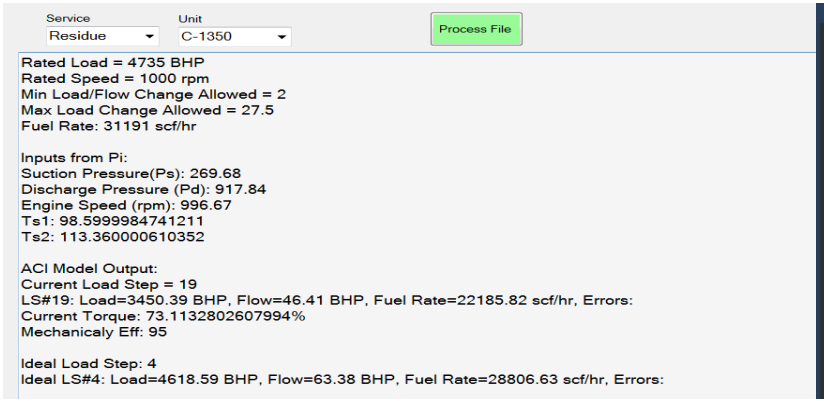
Visual Dashboards & Multidimensional Assessment

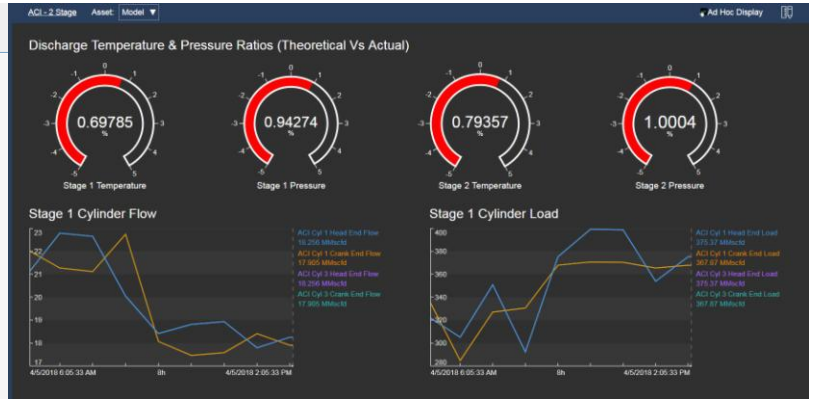
Real-Time Compression Optimization

Using PI AF & First Principles Models to Predict Compressor Operations

dcp Midstream

Case Study: Real-time Compressor Optimization using PI Data and First Principles Models





CHALLENGE

- Historically, we run compressor performance curves during design and then periodically to confirm proper performance
- Changes in gas volume, composition, field pressures can significantly change the optimal operating point

SOLUTION

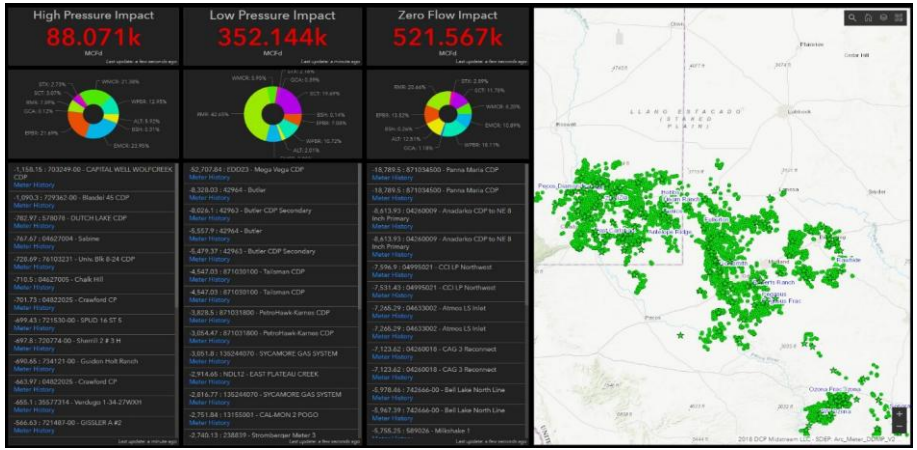
- Compression Health Monitoring Team runs first principle models using real time PI data. Model output is used to define optimal compressor settings for current operation.
- PI Vision displays provides operating conditions based on optimal load step

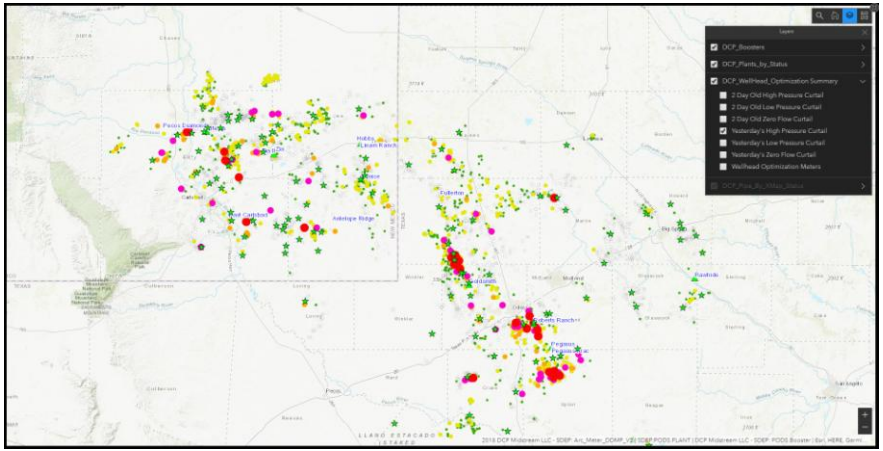
RESULTS

- More quickly identify optimal compressor operating parameters
- Reduced operating costs
- Improved equipment reliability

Linking Operational to Geographic Data

Using Operational and Geospatial Data to Optimize Gas Flow and Gathering Performance





CHALLENGE

- DCP's assets are spread over a wide area, requiring lots of driving miles for operations and maintenance
- With its long distances and extensive interconnections, our gathering system operations must consider geography of our assets

SOLUTION

- Linking operating data with geospatial wellhead and gathering system information will allow rapid understanding of issues and responses to normal and upset conditions.

RESULTS

- **Optimal gas routing**
- **Increased volumes**
- **Greater reliability**
- **Fewer miles driven**

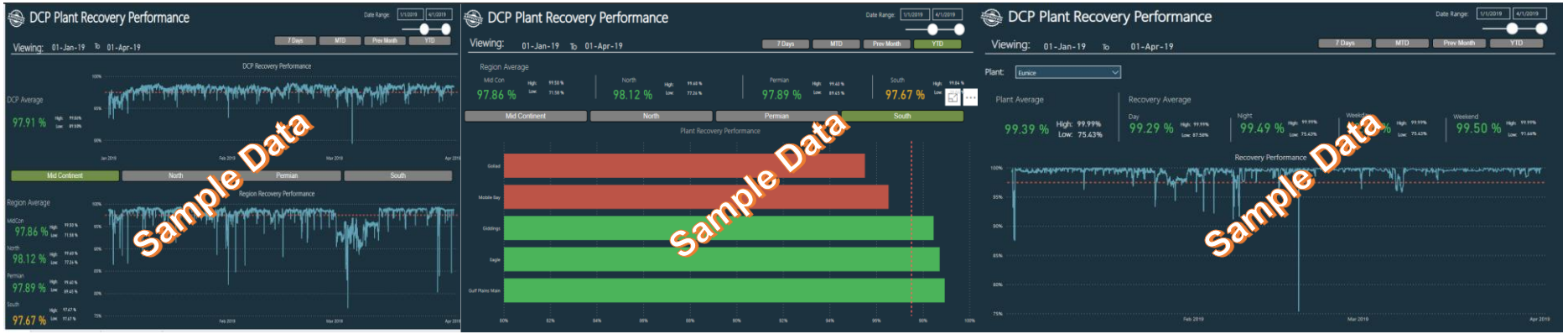
Integrated Landing Page

Decision *Support System is our Company Overview and Path to all Tools*

Regional Field Status Board

Violations of Set Points are Notes for Easy Identification

Reporting using Microsoft Power BI



CHALLENGE

- Find a consistent way to standardize reports across our systems utilizing our PI data

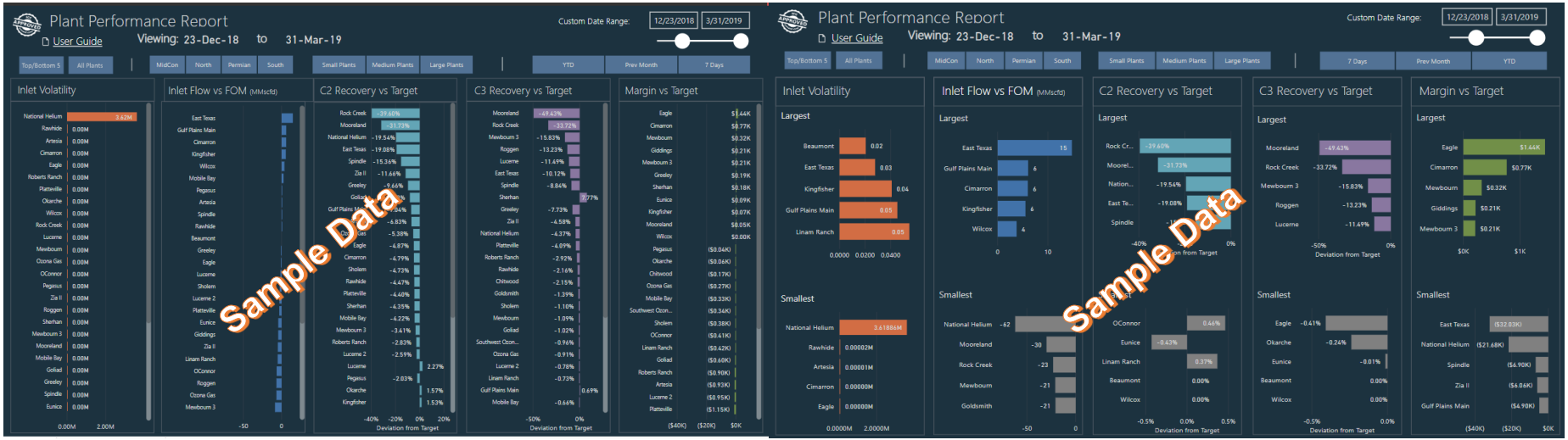
SOLUTION

- Using Power BI to help us make this possible.

RESULTS

- **Standard look and feel**
- **Flexible platform**
- **Easily reached outside our network**

Reporting using Microsoft Power



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Advanced Analytics Using Seeq

CHALLENGE

- Identifying under performing equipment and it's impact on production
- Resulting in lost margin

SOLUTION

- Bring in Seeq for a POC
- Training and Kick start provided
- Use advanced analytics to better enable our ICC Coordinators and Engineers to troubleshoot issues

RESULTS

- **Being able to identify the problem and Solution**
- **Determine it's impact**
- **Revenue back in our pockets**
- **After taking action / dedicating resources**

2018 Areas of Focus and Accomplishments

- Continue the growth of PI AF – a never ending journey
- Expand the role of PI Vision (External facing)
- Trained Hundreds of employees on PI Vision and PI Datalink
- PI Interface Architecture Upgrades
- More robust PI Analytics
- Implement the Decision Support System

Our Focus for 2019 with the PI System

1. Expand the use of data and automation throughout the company
2. Automate as many manual processes as possible
3. Grow the Decision Support System for Corporate use
4. Expand our reporting capabilities
5. Edge data gathering
6. Data quality monitoring
7. Expanding scope of real time process modeling
8. Building a Community of Practice around PI

Speaker Information

Joe Hill

PI System Development Lead

DCP Midstream

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Continuing to Leverage the PI System for Real-Time Operational Intelligence

PI World 2019 Update

Nick Galizia, Oscar Smith, Matt Whiteman

equitrans Midstream

Agenda

- Equitrans Company History & Asset base
- PI System Background & Initial Rollout

Areas of Presentation Focus

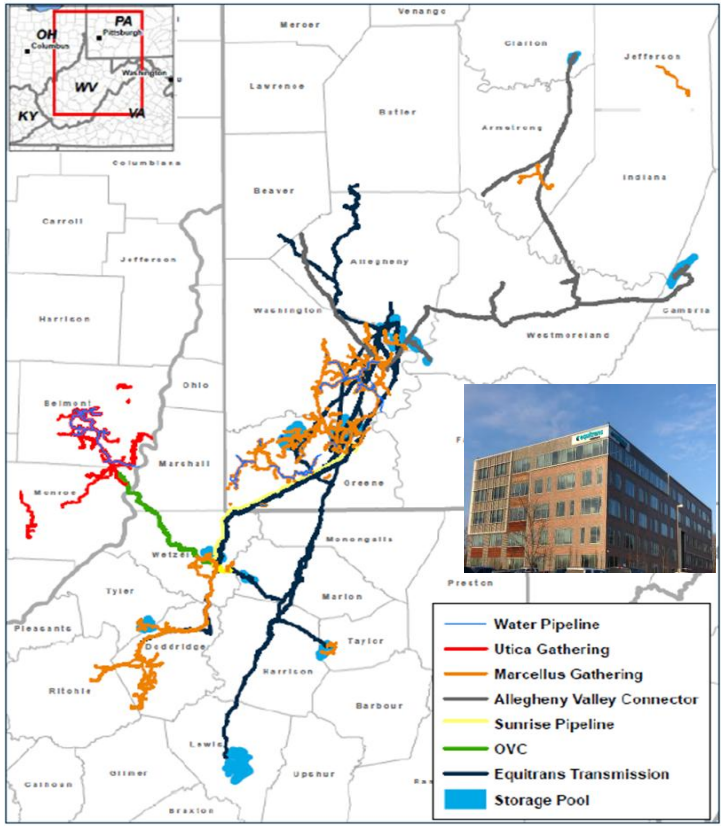
- Operational Event Frame Analysis with TIBCO Spotfire Integration
- 2019 Initiatives:
  - Continued system build-out, integration and reporting initiatives;
  - Event Frame process integration with Maximo Asset/Work Management system;
  - Real-time integration – Engine / Compressor modeling tool;
  - Actual vs Theoretical Revenue Calculator;
- Summary

PI World – Equitrans Midstream

Equitrans Overview

Equitrans Midstream Corporation (NYSE: ETRN)

- Premier natural gas midstream company in the Marcellus and Utica shale
- 3rd largest gas gatherer in the United States
- 700 miles of high pressure gathering pipeline
- 950-mile FERC-regulated interstate pipeline
- ~ 500,000 HP of compression
- #1 customer is the largest gas producer in the U.S.



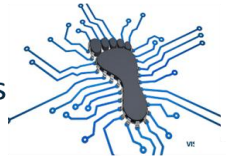
Operational Intelligence System

	"What it IS NOT"	"What it IS"
	Urgent	**Not Urgent**
Important	**Quadrant 1** **SCADA Alarm** **GAS Control** **Control System Alarm**	**Quadrant 2** **Operational Intelligence System** **Notifications** ***Activities*** **Preventive** **Planning** **Process Improvement**
Not Important	**Quadrant 3** **Activities** • Interruptions, some callers • Some email, some reports • Some meetings • Proximate, pressing matters • Popular activities **Results** • Short term focus • Crisis management • Reputation – chameleon character • See goals/ plans as worthless • Feel victimized, out of control • Shallow or broken relationships	**Quadrant 4** **Activities** • Trivia, busy work • Some email • Personal social media • Some phone calls • Time wasters • Pleasant activities **Results** • Total irresponsibility • **Dependent on others** • **or institutions for basics**

Operations Intelligence System Journey

Expanding Digital Footprint

- **2015 – Pilot – One Gathering Site**
  - Saturn Compressor Station
  - 7 Engine/Compressor Units
  - ~9000 TAGS

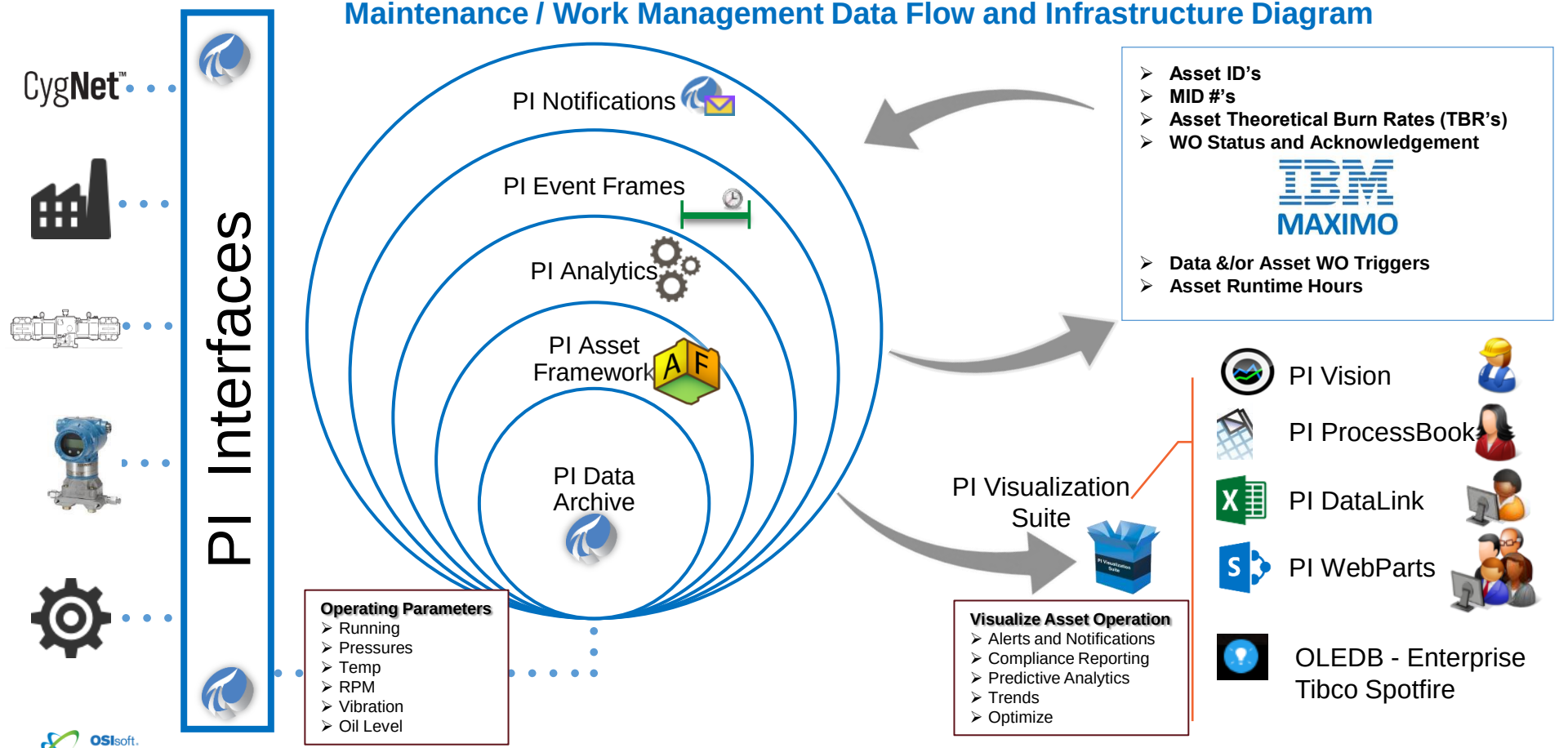


- **By End of 2019 – 41 locations**
  - 93 Engine/Compressor Units
  - 575,000 Horsepower
  - 16 Gathering facilities
  - 10 Transmission facilities
  - 1 Storage facility
  - 10 M&R sites
  - 4 Interconnect Sites

- **More than 150,000 TAGS /sec**
- **PI System (AF) Metrics:**
  - 1400 Analysis templates
  - 16700 Analyses
  - 186 Element templates
  - 4200 Elements
  - 828 Notification rule templates
  - Supported by 2 FTE resources

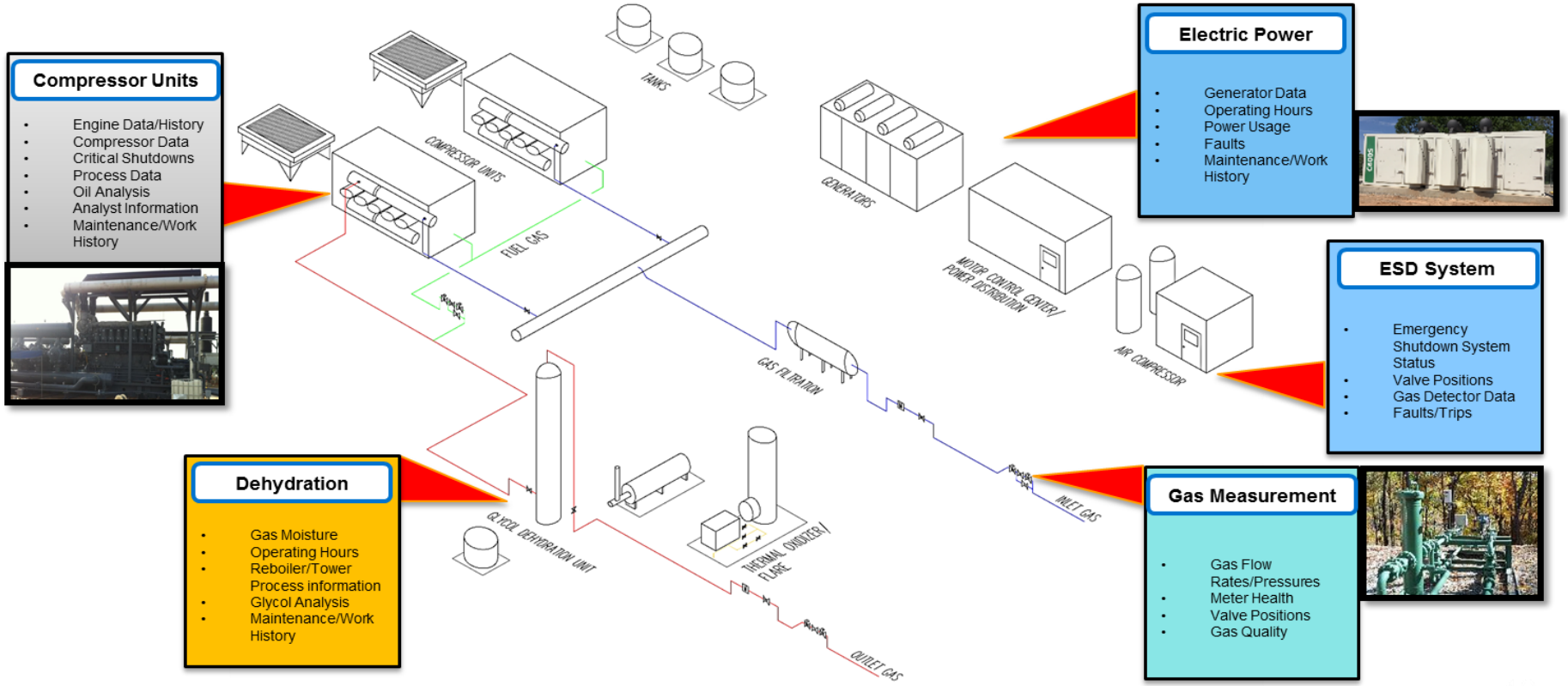
CSE ICON

Operational Intelligence System Preventive Maintenance / Work Management Data Flow and Infrastructure Diagram



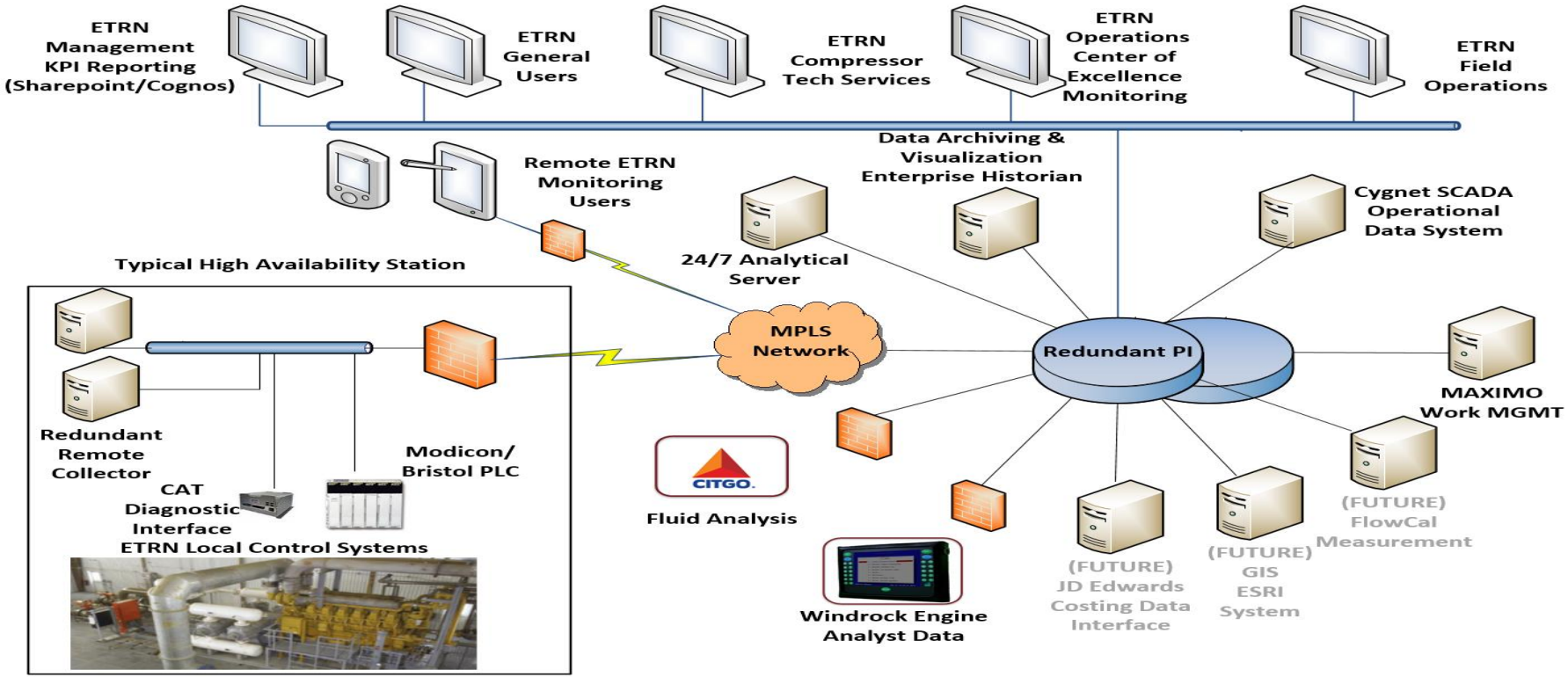
Operations Intelligence System Overview

Compressor Site Overview



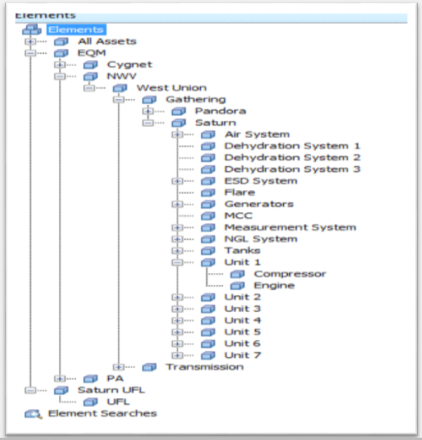
Operations Intelligence System Overview

System Network Architecture



Operations Intelligence System Overview

Features and Functionality - Improving Reliability with Prevention & Predictive Modeling

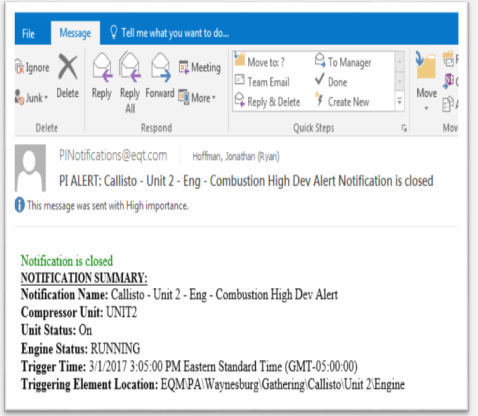


PI Asset Framework (PI AF)

- Develop Hierarchy of Compressor Station Assets
- Organization of Data Into Useful Sets
- Standardization Across Sites
- Templates for Scalability
- Translation/Integration With Other Business Systems

PI Vision

- Dashboards for Operational Monitoring
- Multiple Sources of Data Combined Into Single View
- Pair Analytics w/Real-Time Values
- Single Point Access Across Organization



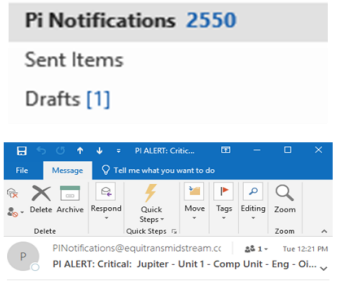
PI Event Frames & Notifications

- 24/7 Monitoring & Communication of Anomalies
- Failure Detection, Efficiency Monitoring, Work Mgmt.
- Improve Operational Awareness
- Eliminate “Digging” for Issues

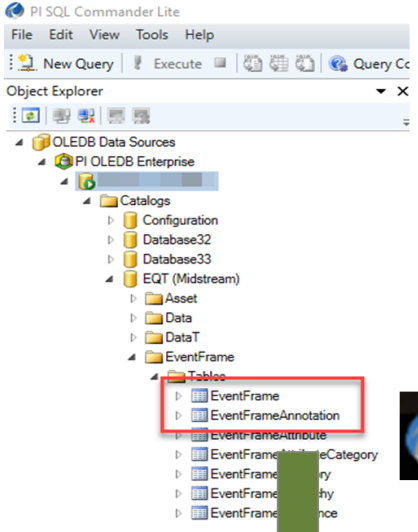
PI World – Equitrans Midstream

Operational Event Frame Analysis

Event Frame Dashboard



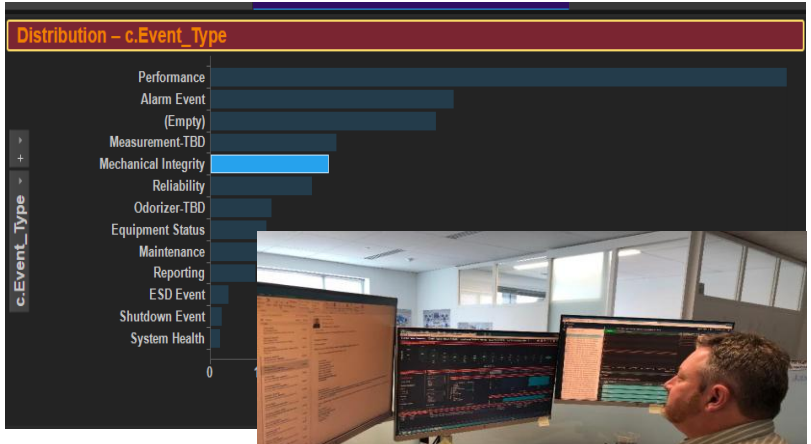
- Generating 100-200 email notifications per day
- No good way to analyze events with email notifications
- Wanted to leverage Spotfire's data visualization and analysis tools
- Utilized PI OLEDB Enterprise -> SQL Query & TIBCO Spotfire

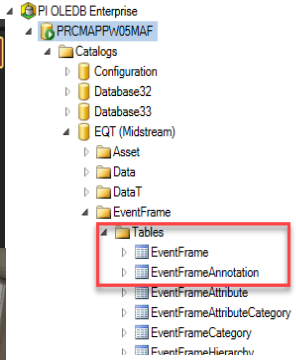


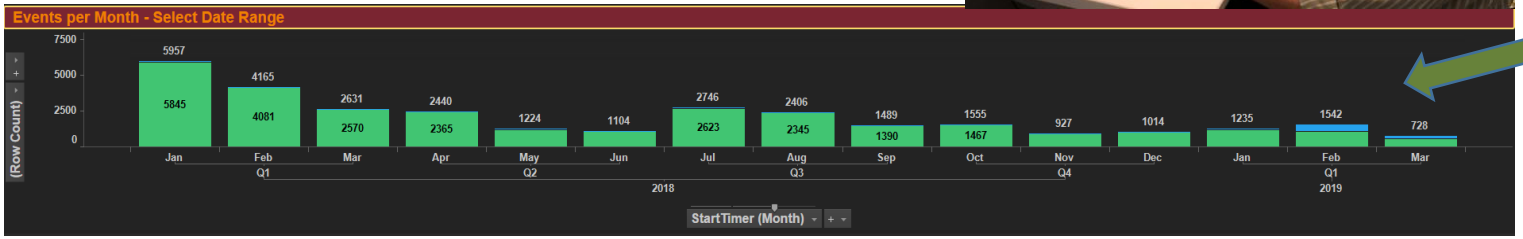
Notification Name	Site	Unit	Occurences in Last 24 Hours	Occurences in Last Week	Occurences in Last Month	Occurences YTD	Start Time of Last Event	vent Statu	Time Open (Hours)
Unit 4 - Comp Unit - Eng - Combustion High Dev Alerts -16 Cylinder	Callisto	Unit 4	34	38	38	41	4/9/18 5:50 AM	OPEN	0
Unit 5 - Comp Unit - Eng - Combustion High Dev Alerts -16 Cylinder	Callisto	Unit 5	0	12	13	77	4/5/18 8:55 PM	CLOSED	
Unit 4 - Comp Unit - Comp - Throw Disch Temp Theo v Actual - 6 Throw	Callisto	Unit 4	0	10	10	21	4/7/18 11:10 PM	OPEN	30
Unit 5 - Comp Unit - Comp - Load Step Deviance	Callisto	Unit 5	0	7	8	56	4/7/18 11:10 PM	OPEN	30
Bay B - Capstone - System Severity Alerts - Standard	Callisto	Bay B	0	5	5	14	4/6/18 2:01 PM	CLOSED	
Bay C - Capstone - System Severity Alerts - Standard	Callisto	Bay C	0	5	5	14	4/6/18 2:01 PM	CLOSED	
Bay E - Capstone - System Severity Alerts - Standard	Callisto	Bay E	0	4	4	5	4/7/18 10:40 PM	CLOSED	
Unit 4 - Comp Unit - Comp - Load Step Deviance	Callisto	Unit 4	1	4	4	25	4/8/18 2:55 PM	CLOSED	
Unit 5 - Comp Unit - Comp - Throw Disch Temp Theo v Actual - 6 Throw	Callisto	Unit 5	0	4	4	48	4/7/18 11:10 PM	OPEN	30
Unit 3 - Comp Unit - Eng - Combustion High Dev Alerts -16 Cylinder	Callisto	Unit 3	0	4	4	5	4/4/18 12:50 AM	CLOSED	
Unit 3 - Comp Unit - Eng - High Oil Press Alerts - Standard	Callisto	Unit 3	1	4	7	136	4/8/18 5:05 PM	OPEN	12
Unit 1 - Comp Unit - Comp - Throw Disch Temp Theo v Actual - 6 Throw	Callisto	Unit 1	0	3	3	22	4/7/18 11:10 PM	OPEN	30
Dehydration System 1 - Dehy - TOX Fault - Standard	Callisto	Dehydration System 1	0	3	3	13	4/3/18 6:25 PM	CLOSED	
Bay E - Capstone - Fault Code Alerts - Standard	Callisto	Bay E	0	2	2	9	4/7/18 10:45 PM	CLOSED	
Unit 2 - Comp Unit - Eng - Combustion High Dev Alerts -16 Cylinder	Callisto	Unit 2	1	2	2	68	4/8/18 5:00 PM	OPEN	13
Generators - Capstone MT Down	Callisto	Generators	0	2	7	102	4/5/18 2:14 PM	CLOSED	
Bay A - Capstone - Fault Code Alerts - Standard	Callisto	Bay A	0	1	1	8	4/2/18 3:50 PM	CLOSED	
Unit 3 - Comp Unit - Comp - Final Discharge v Station Discharge	Callisto	Unit 3	0	1	1	53	4/7/18 10:20 PM	CLOSED	
Unit 3 - Comp Unit - Shutdown - Standard	Callisto	Unit 3	0	1	1	18	4/5/18 4:16 PM	CLOSED	
Unit 3 - Comp Unit - Manual Data Update Alert	Callisto	Unit 3	1	1	1	8	4/9/18 6:00 AM	OPEN	0
Unit 5 - Comp Unit - Shutdown - Standard	Callisto	Unit 5	0	1	1	10	4/6/18 2:44 AM	CLOSED	
Unit 3 - Comp Unit - Eng - High Oil Filter dP Alerts - Standard	Callisto	Unit 3	0	1	1	8	4/5/18 4:30 PM	OPEN	85
Stale Data Alert	Callisto	Stale	0	0	0	12	3/22/18 6:05 PM	OPEN	419
Bay B - Capstone Starts	Callisto	Bay B	0	0	0	2	3/27/18 9:10 AM	OPEN	308
Unit 1 - Comp Unit - Comp - Lube Oil Analysis Copper Out of Limit	Callisto	Unit 1	0	0	0	3	3/13/18 11:15 AM	OPEN	642
Unit 1 - Comp Unit - Comp - Lube Oil Analysis Oxidation Out of Limit	Callisto	Unit 1	0	0	0	3	3/13/18 11:15 AM	OPEN	642

PI Event Frame Dashboard

- Classified Event Frames by Type
- Reliability personnel review notifications and work with Ops Center to create Maximo work orders
- EF Notification reduction of 70%
- Next steps to integrate with Shutdown process

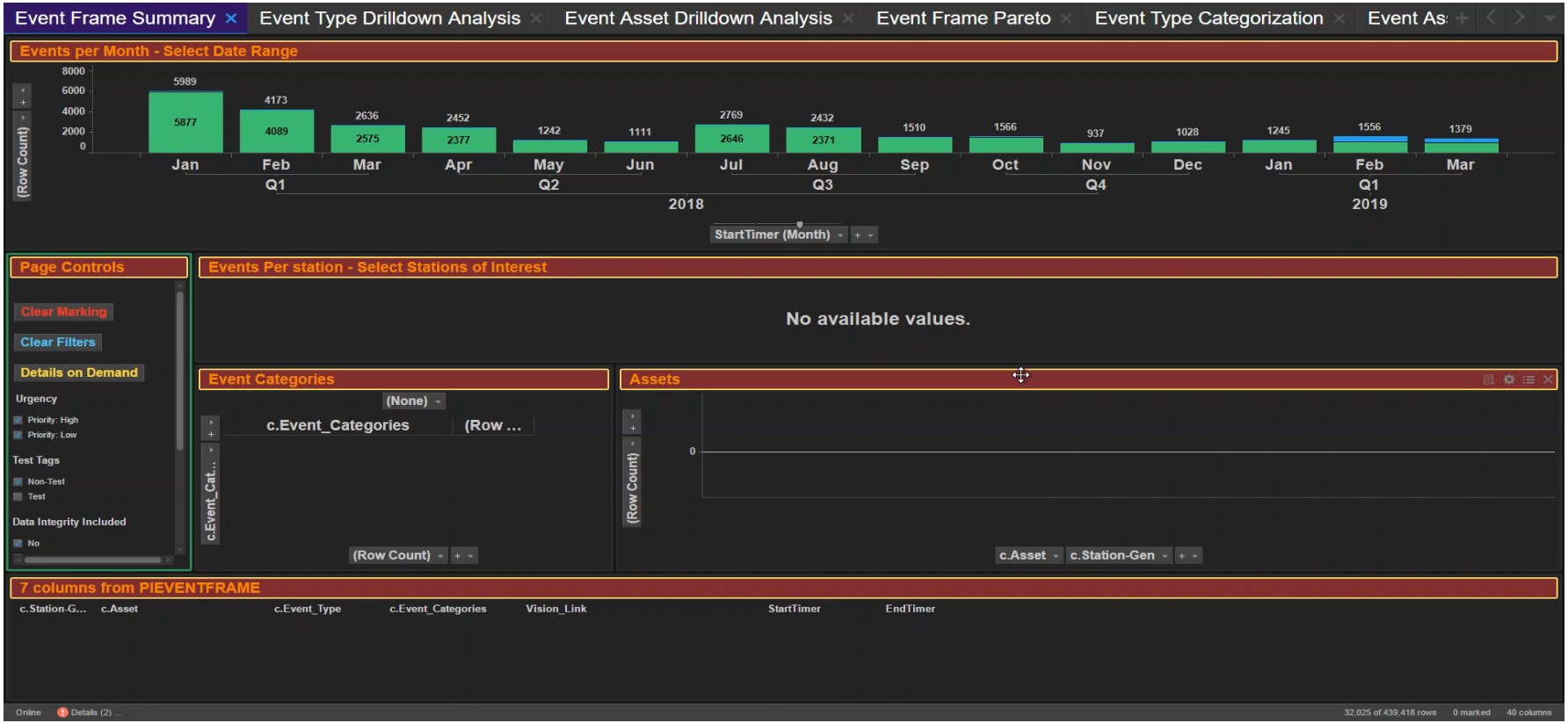






TIBCO Spotfire®

Spotfire – EF Demo



PI World – Equitrans Midstream

2019 Initiatives

2019 Goals and Initiatives

Operations Intelligence System

Objectives:

- Digitally Transform Equitrans business functions with a focus on people, process & technology
- Automate, streamline and digitize the Midstream business

Initiatives:

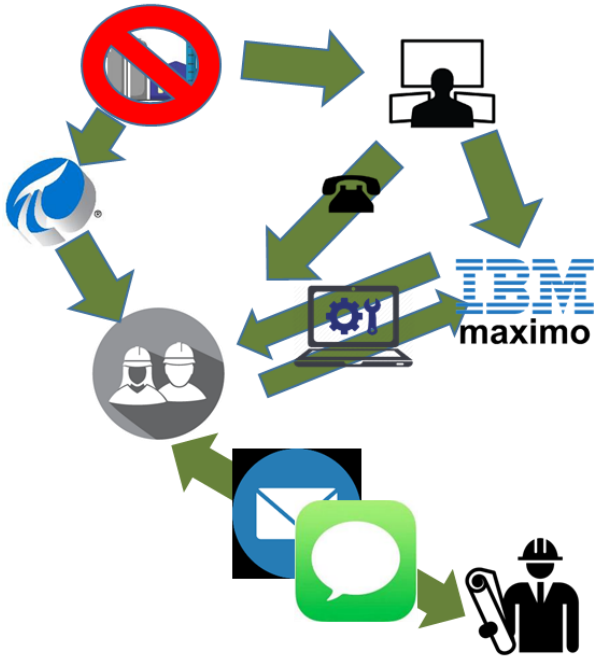
- Continued roll-out to greenfield compressor stations
- Equipment diagnostics and virtual inspections
- Environmental reporting

- Asset shutdown process
  - PI Event Frame Integration
- Engine / Compressor Modeling Tool
  - Real time integration

2019 Initiatives

Asset Shutdown Process (Integrate PI Event Frames with Maximo EAM System)

Current State



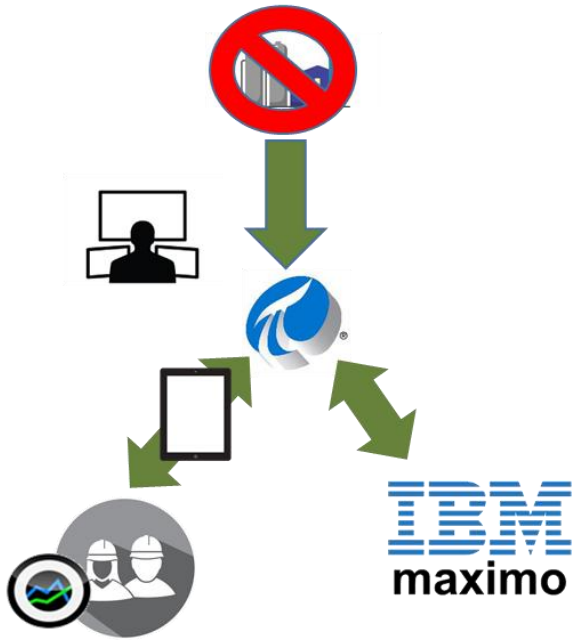
Challenges:

- Current process is manual
- Does not leverage existing technology and PI data
- Email /Text communication not available for future troubleshooting
- Maximo data incomplete

Benefits:

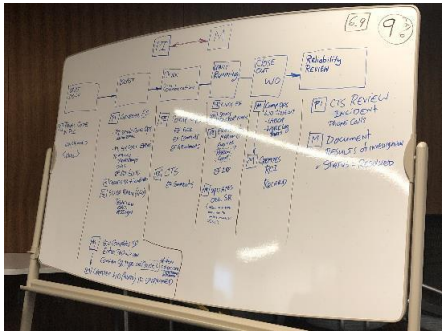
- Provide immediate data
- Memorialize prior shutdowns
- Streamline documentation process

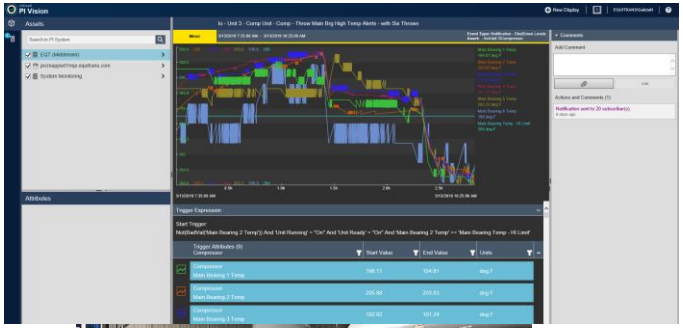
Future State



2019 Initiatives

Asset Shutdown Process (Integrate PI Event Frames with Maximo EAM System)





Investigate / Plan → **Collaborate** → **Pilot**

2019 Initiatives

Integrating PI Vision into Compressor Shutdown Process

Reply Reply All Forward IM

P PINotifications@equitransmidstream.com 1 Wed 3/20

TEST_PI_ALERT: None: TEST - Jupiter - Unit 2 - Shutdown Even...

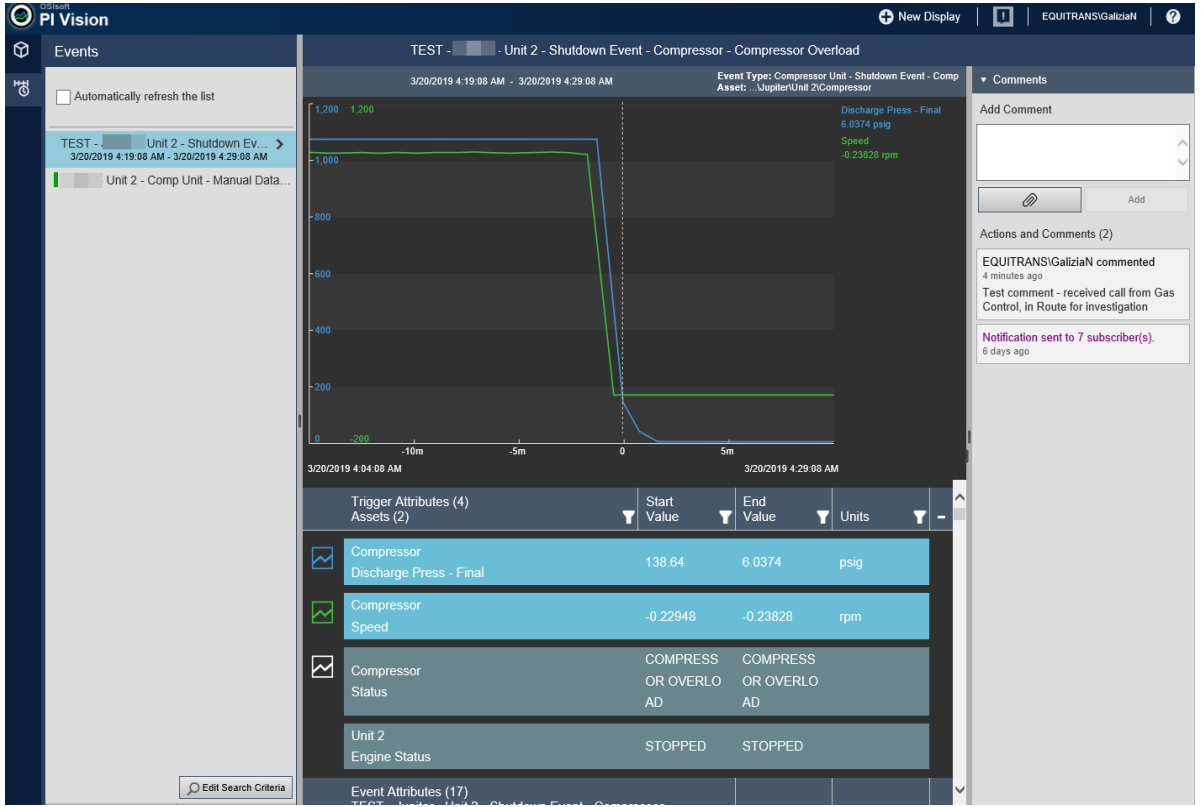
NOTIFICATION SUMMARY:

Notification Name: TEST - Jupiter - Unit 2 - Shutdown Event - Compressor - Compressor Overload
Trigger Time: 3/20/2019 4:19:08 AM Eastern Daylight Time (GMT-04:00:00)
Triggering Element Location: EQM\PA\Waynesburg\Gathering\Jupiter\Unit 2\Compressor
Severity: None

Compressor Status: COMPRESSOR OVERLOAD
Engine Status: STOPPED
Compressor Speed: -0.22905233502388
Engine Speed: 0
Load Step: 5
Suction Control Valve: 100
AMP Load: 0
eRCM Current Torque: 100
CAT Engine Load: 0

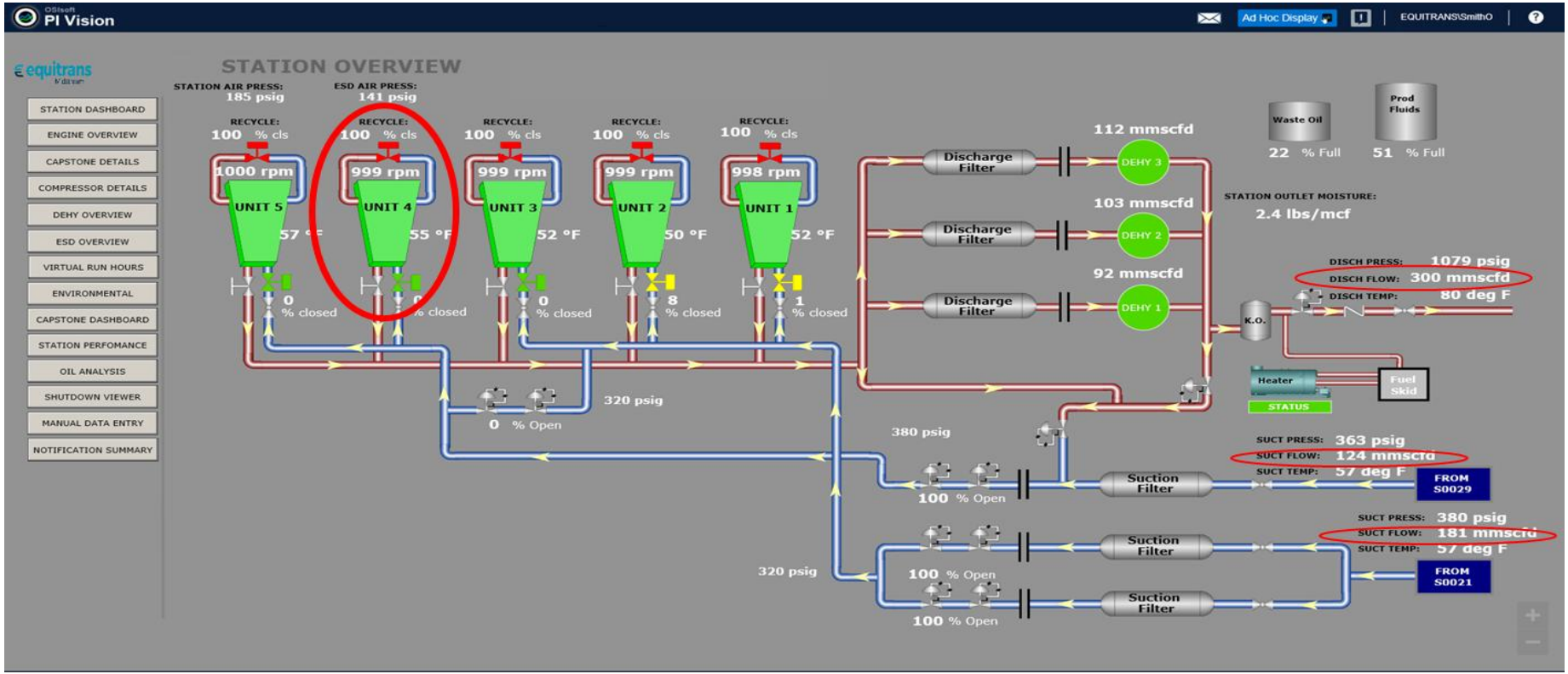
Triggering Condition: {Error inserting result}

Event Frame Details: Event Details Hyperlink



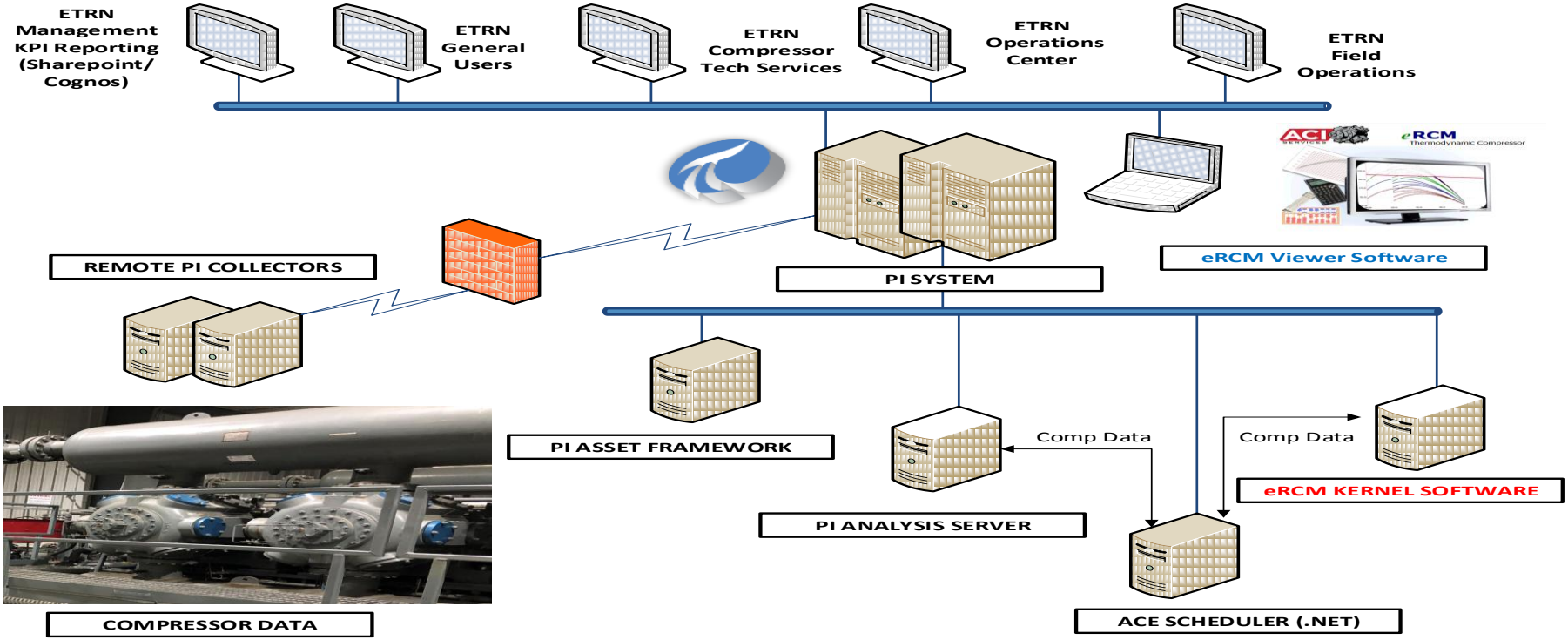
2019 Initiatives

Actual vs. Predictive Modeling



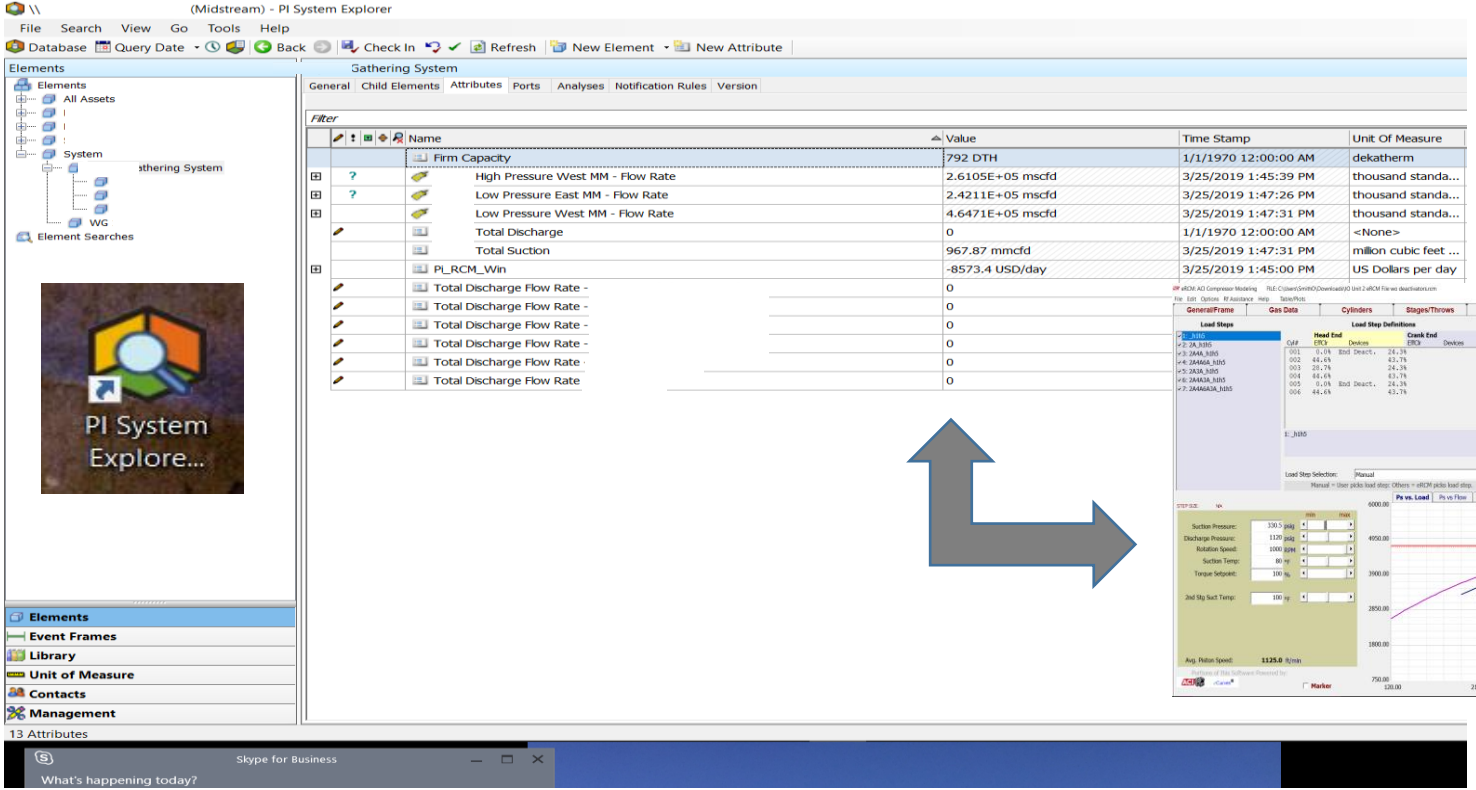
2019 Initiatives

Predictive Thermodynamic Compressor Modeling Tool



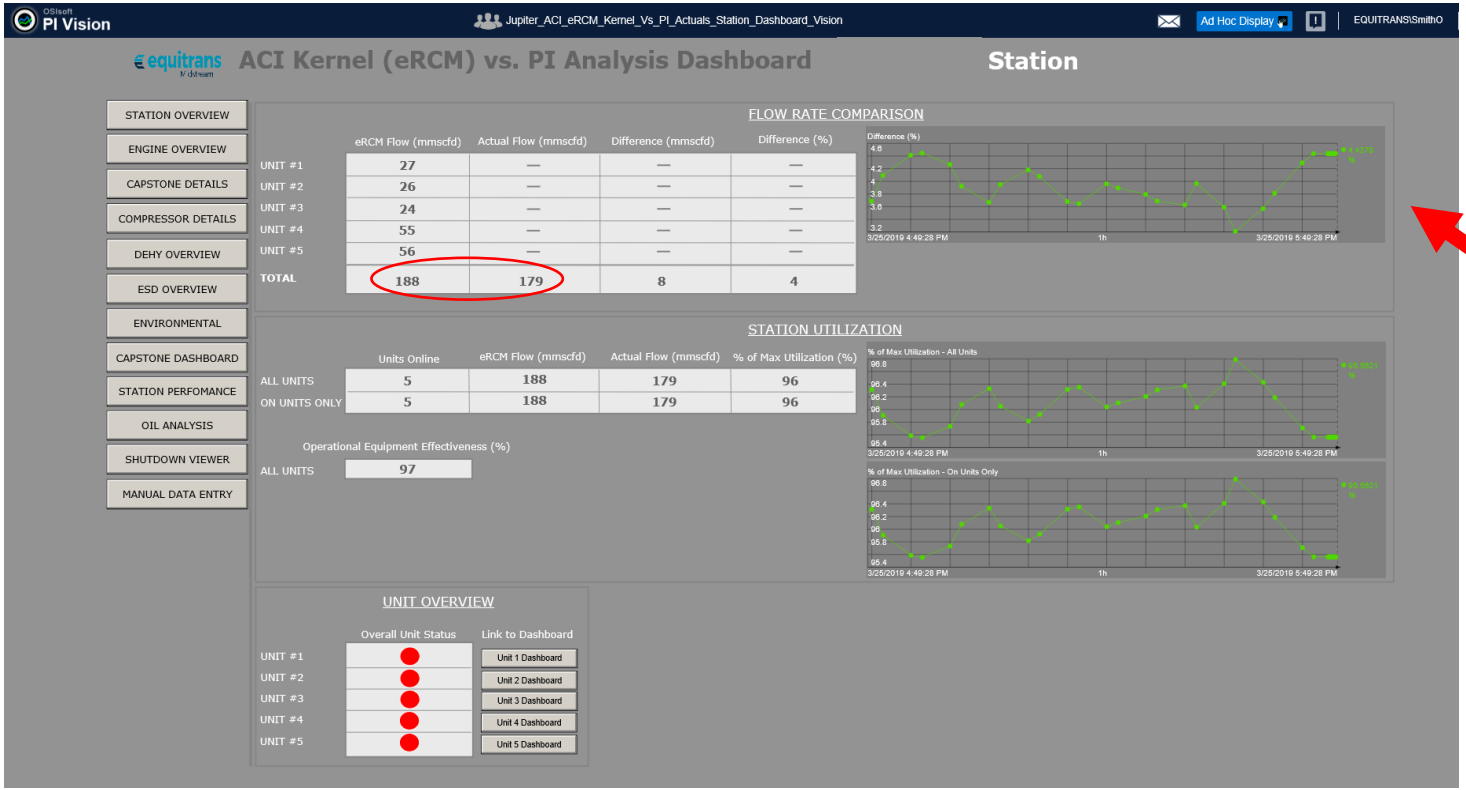
2019 Initiatives

Modeling Tool - PI System Explorer – Analysis / Calculations



2019 Initiatives

Business Case – Actual versus Theoretical Revenue Calculator

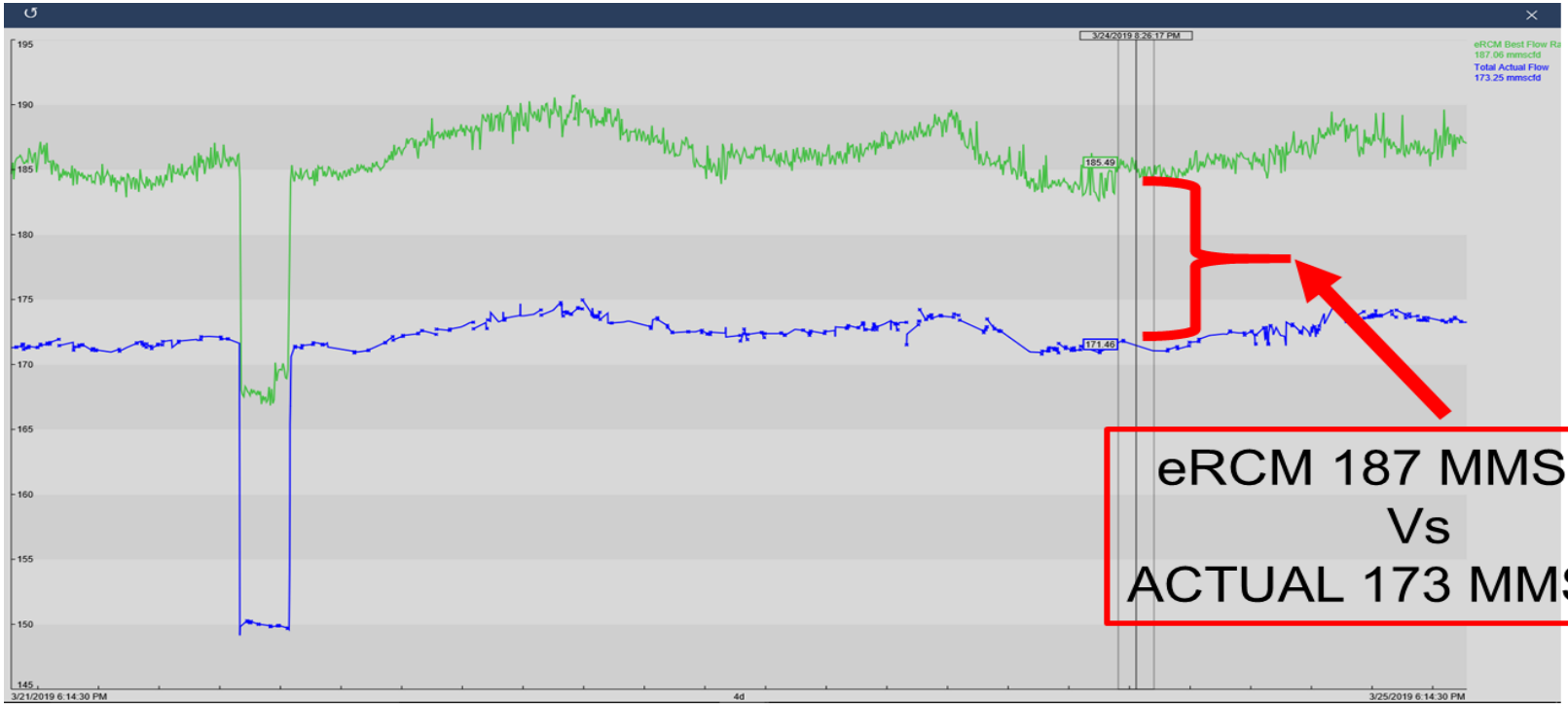


Flow Deviation
~4.5%

2019 Initiatives

Business Case – Actual versus Theoretical Revenue Calculator

Numbers are for Illustration only – do not represent actual information

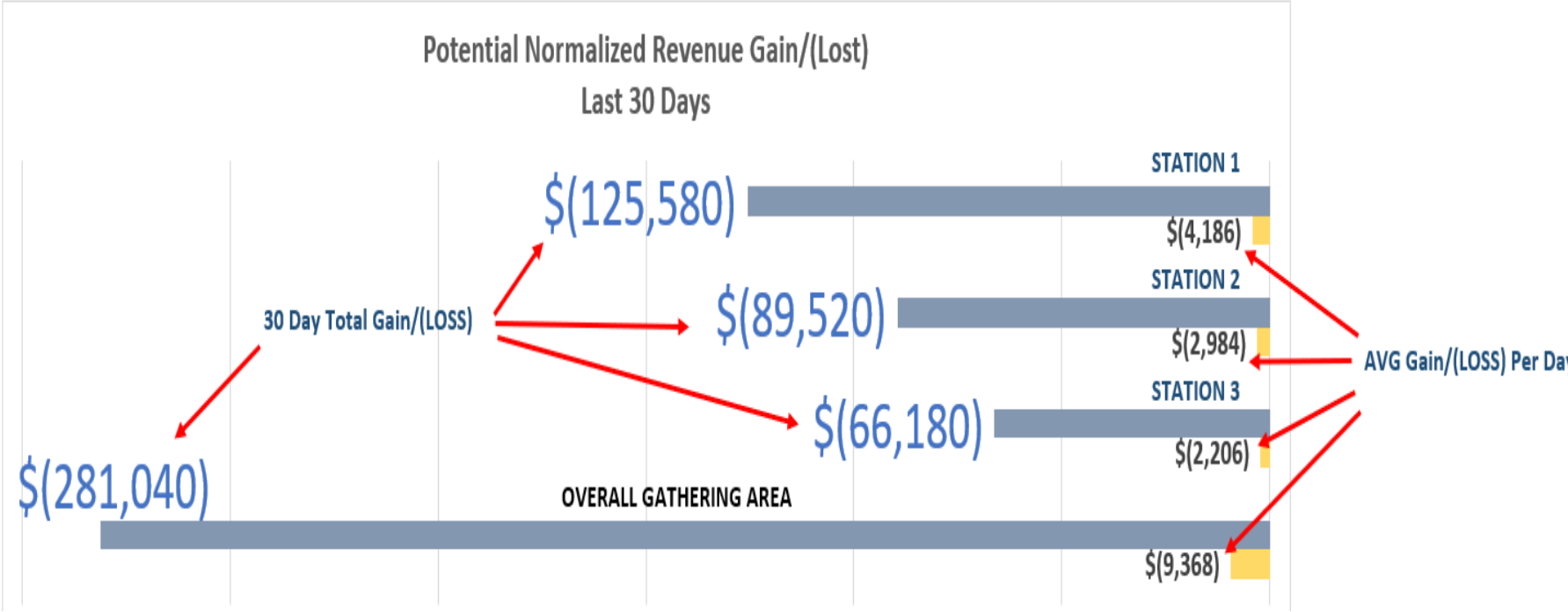


eRCM 187 MMSCFD
Vs
ACTUAL 173 MMSCFD

2019 Initiatives

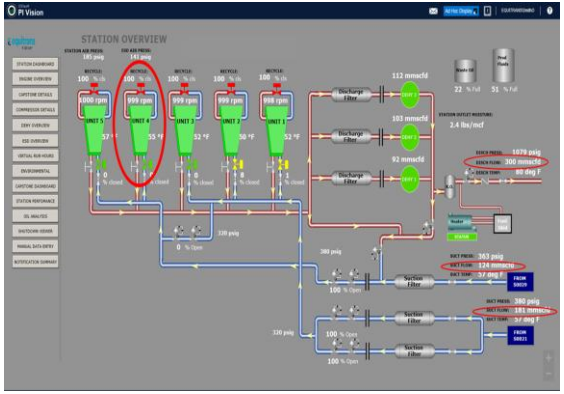
Business Case – Actual versus Theoretical Revenue Calculator

Numbers are for Illustration only – do not represent actual information



Leveraging the PI System for Real-Time Operational Intelligence

equitrans Midstream



CHALLENGE

Continue our Digital Transformation with new Business Focused Applications

- Great initial value from leveraging the PI System as an operational data integration, applications, and analytics infrastructure
- Meet Organizational request for more operational intelligence

SOLUTION

Developed 2019 Areas of Focus to Guide Development; Continue to Leverage the PI System as an operational data infrastructure

- Enhanced Operational Intelligence
- Act. vs Pred. Compressor Modeling
- Act. Vs Theoretical Financial Performance
- Integration with Maximo
  - PI Event Frames
  - Compressor Shutdown Process

RESULTS

Continued Strong Business Value and Organizational Cultural Change

- Enhanced, proactive decision making from self-serve access to contextualized operational intelligence
- Increased asset utilization
- Increased financial performance via reduced O&M and Increase in effective system capacity

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Questions?

Please wait for the **microphone**

State your **name & company**

Please remember