



OCTOBER 24, 2023

It's RAD: Operating by priority using anomaly detection

Leveraging the AVEVA PI System for rapid anomaly detection (RAD) in a hybrid cloud architecture

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Agenda

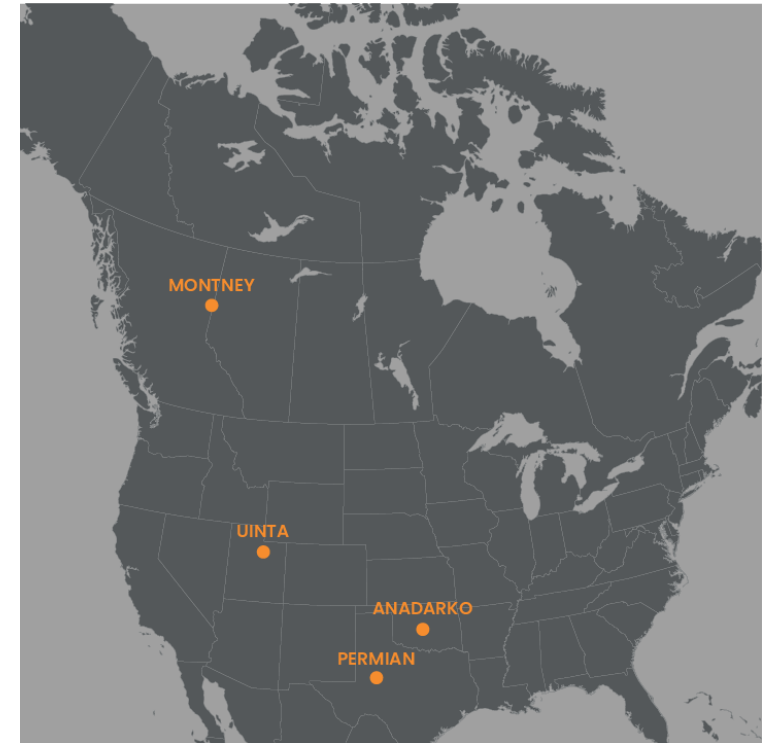
- Ovintiv Overview
- Ovintiv PI System Overview
- Initial Challenge
- Evolution of Rapid Anomaly Detection
- Rapid Anomaly Detection in Depth
- Cost Savings
- Lessons Learned
- Future Plans
- Q&A

Ovintiv Overview

High quality balance multi-production and basin portfolio

- 573 production (MBOE/d)
- 5211 Total Net Productive Wells
- 48% Gas, 52% Liquids
- E&P Focused
- ~1700 employees across multiple geographic locations

- ✓ **Premium Portfolio**
 - Each asset generates substantial Free Cash Flow^T
 - Provides risk mitigation against single basin headwinds
- ✓ **Multi-Basin Advantage**
 - Cross-basin learnings reinforce innovative culture
 - Operational best practices distributed across the portfolio
- ✓ **Multi-Product Commodity Exposure**
 - Balanced production across oil & condensate and gas
 - Maximized price realizations through market diversification



^T Non-GAAP measures defined in advisories. For additional information regarding non-GAAP measures see the Company's website under the Investors tab.
¹⁾ Premium defined as >35% at \$55 WTI and \$2.75 NYMEX.

Ovintiv PI System Journey

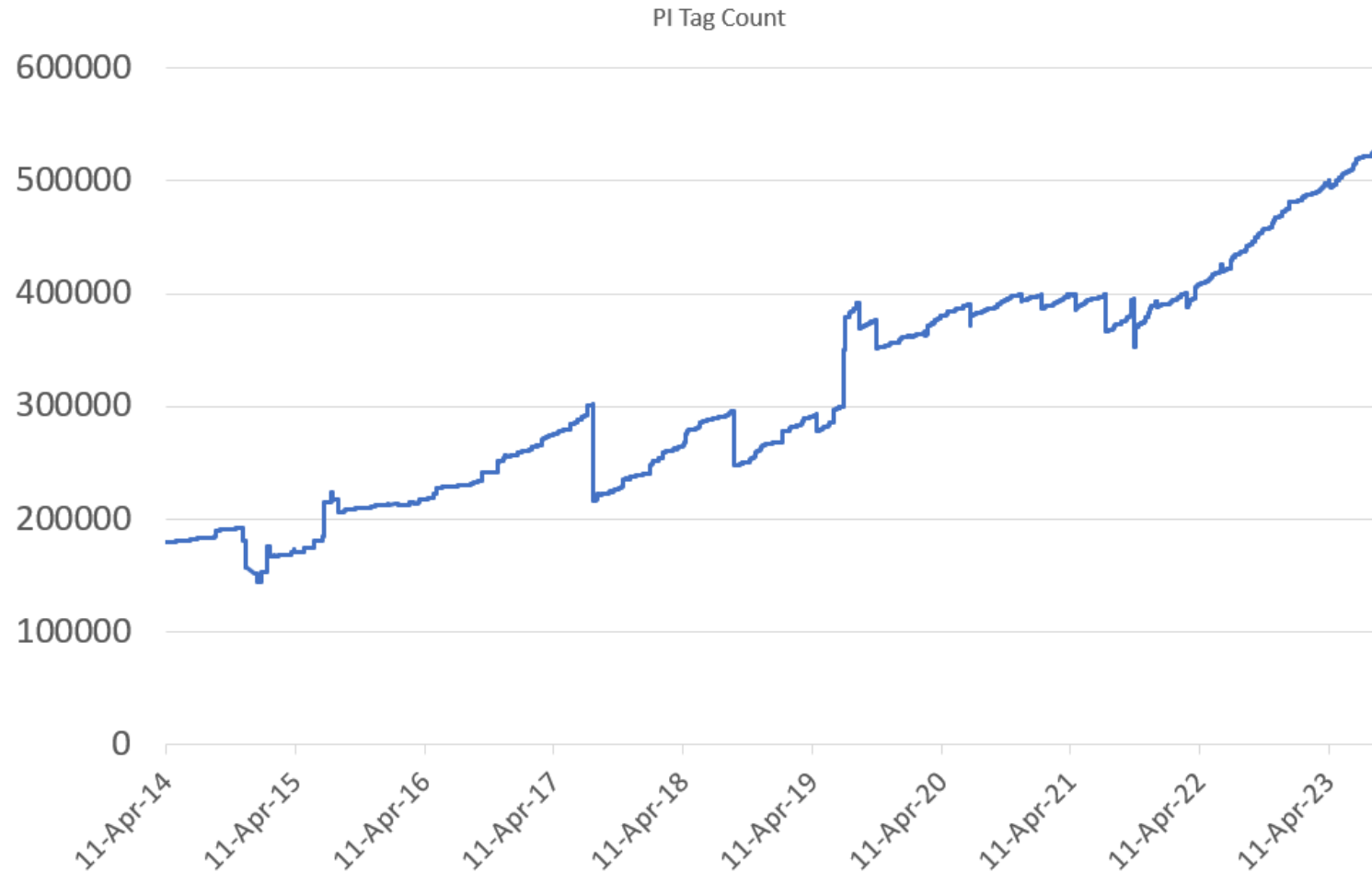
From a “historian” to an OT integration, applications and streaming analytics infrastructure

- 1997 initial PI System install
- 600,000 PI tag system
- 50 interfaces
- 200+ automated scheduled reports
- 100 PI AF templates
- ~50,000 elements
- ~1,000,000 PI AF analyses/streaming calculations and analytics
- High availability, PI Data Archive collective

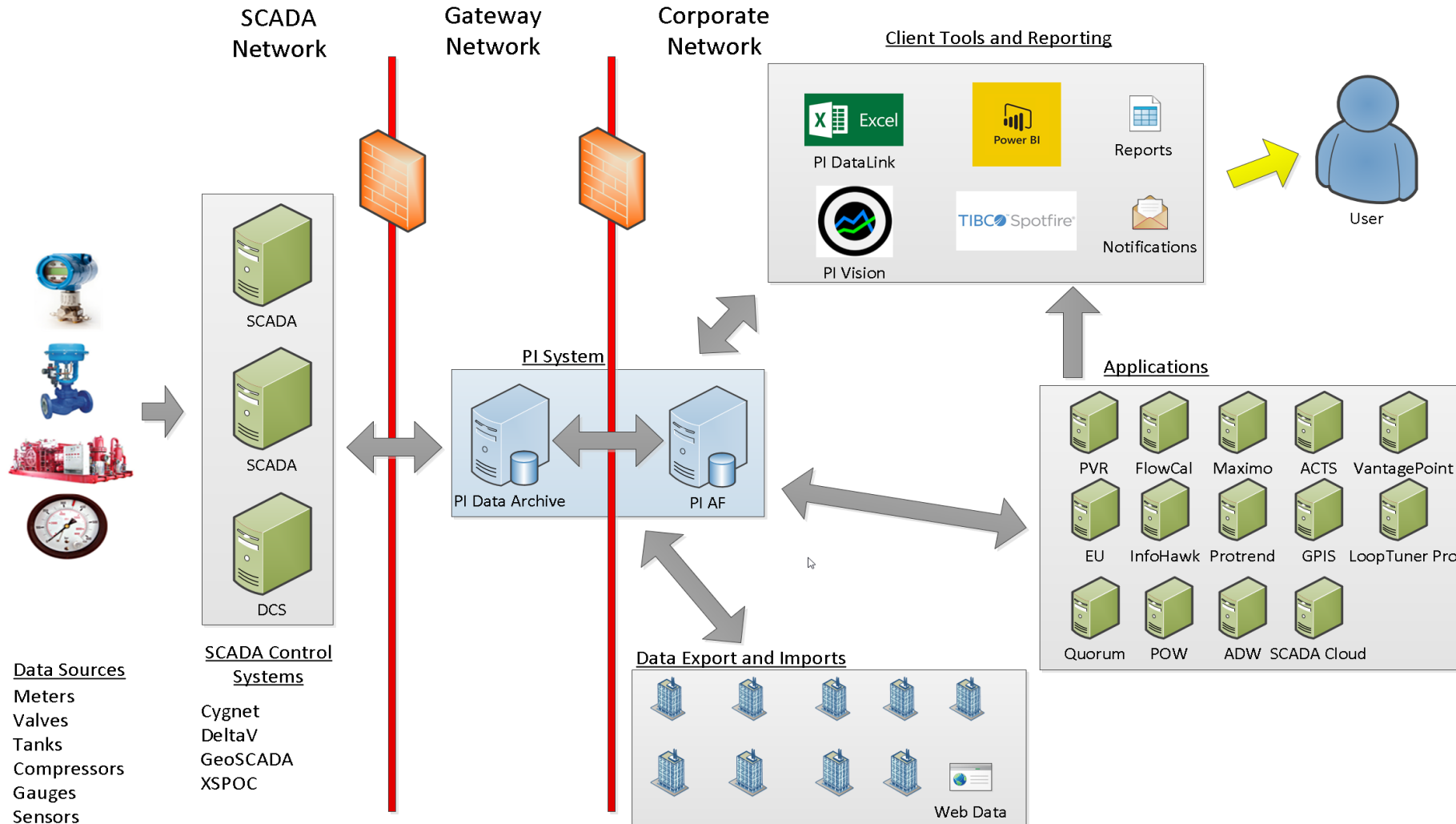


PI System Tag Growth Since 2014

Enabling business value and a data centric decision-making culture

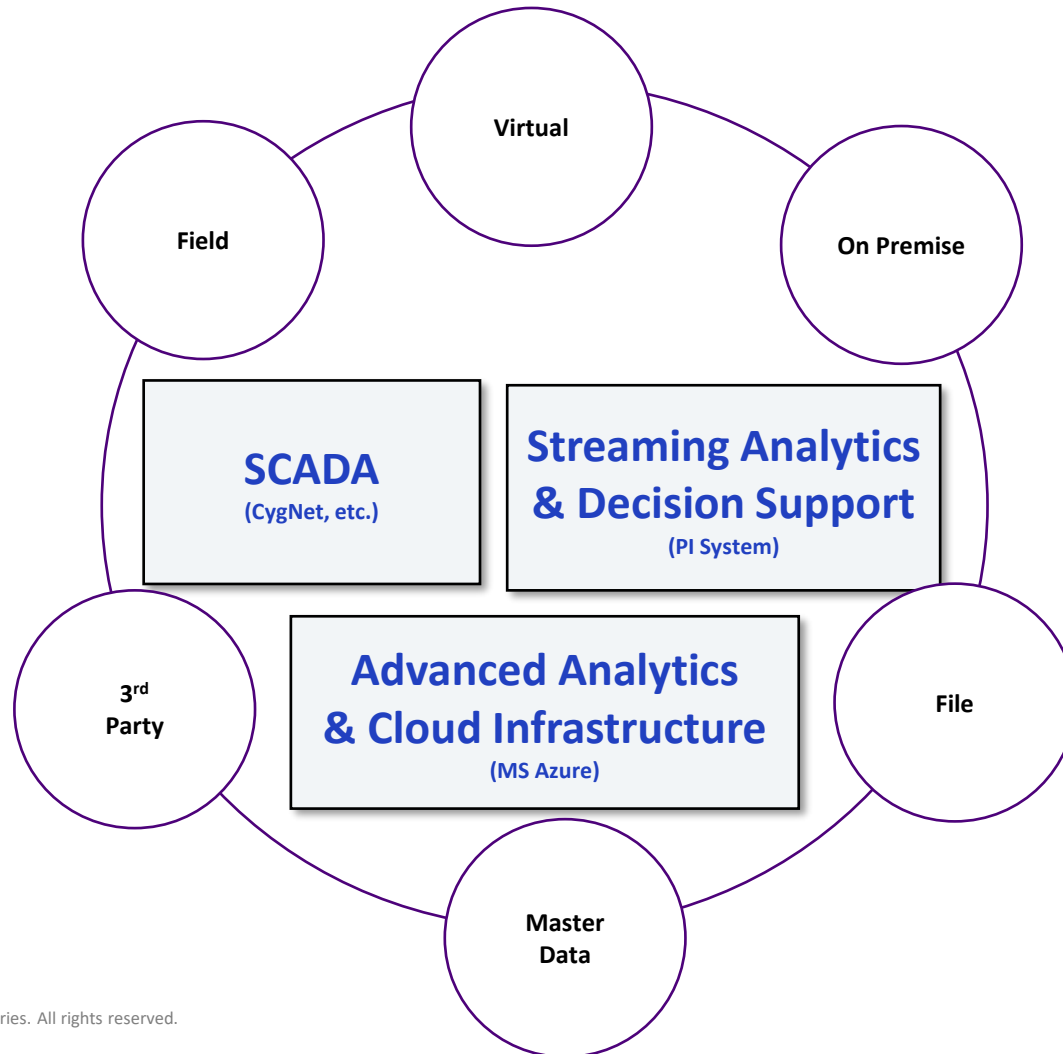


PI System Overview



Big Data Ecosystem

Connected Data Model



- *Each has its own strengths and weaknesses*
- *Together they make up a near perfect solution*
- *Work as a cross functional team on how to deliver your data product*
- *Analytics implemented in “layers” with the PI System/PI AF being foundational*



Rapid Anomaly Detection (RAD)



Initial Challenge

- Identify leaking tanks as quickly as possible to reduce spill volumes



Challenge

- Tank leaks are difficult to detect and can go unnoticed until a site visit by operations.
- Faster identification of possible leaks will reduce the volume of a spill.

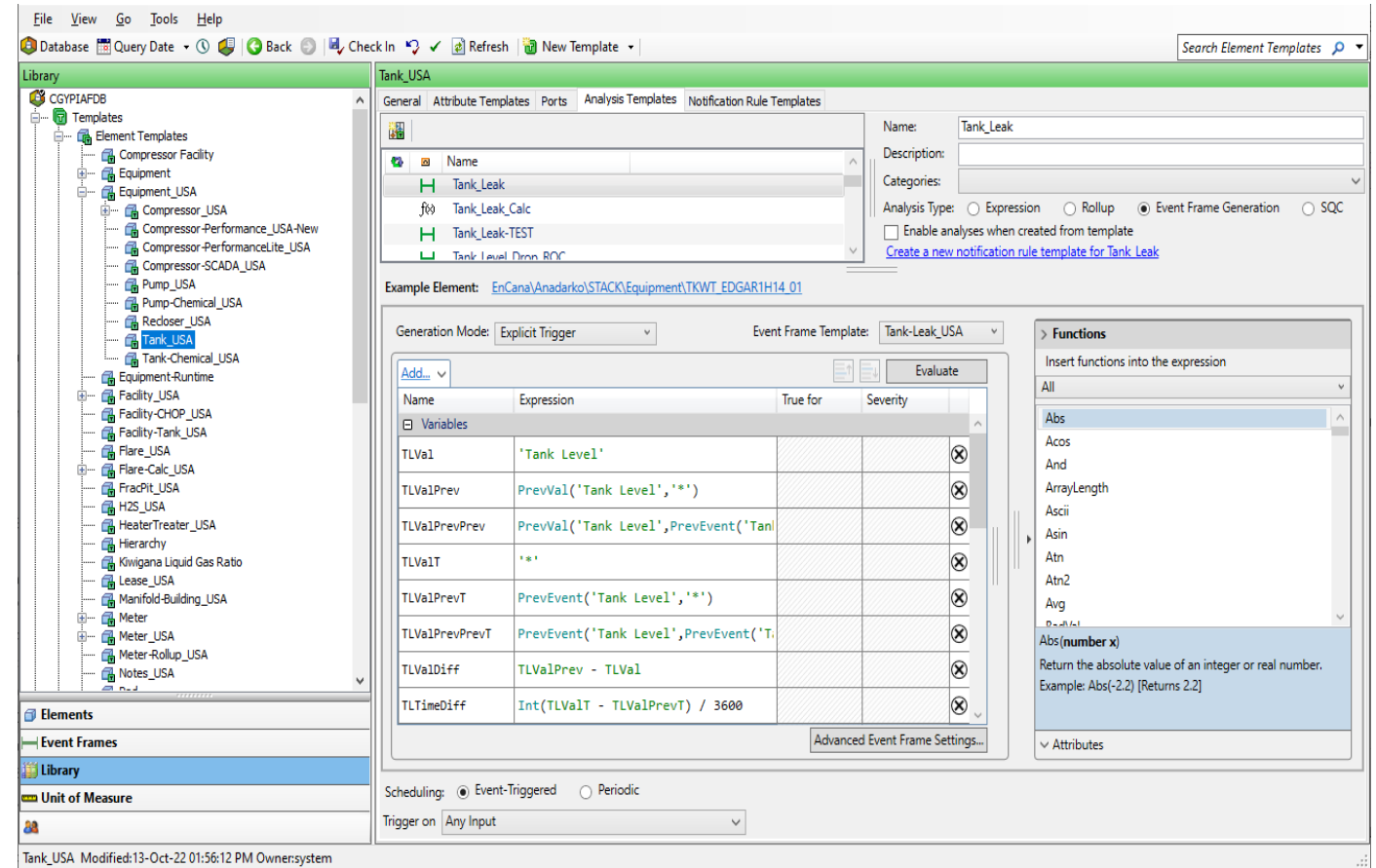
Idea

Using PI AF Analytics, develop an algorithm to monitor the tank level and slow rate of decline outside the normal of a pump rate or truck haul to have suspected leaks identified quickly and use PI Notifications to alert operations of a potential leak.

Tank Leak Early Identification

Solution

- Tanks were modeled in PI AF as an element template
- Algorithm required multiple iterations to become effective – leveraged powerful backfilling capabilities
- New template analysis to create event frames when a possible leak would occur
- Emails were sent using PI Notifications to USA Integrated Operations Center (IOC) identifying possible leaks
- IOC would review the data and notify operations to investigate
- Previous tank leaks were used to create and test algorithm



The screenshot shows the PI AF software interface for configuring an analysis template named 'Tank_Leak'. The left pane shows a library tree with 'Tank_USA' selected. The main pane shows the configuration for 'Tank_USA' with the following details:

- Name: Tank_Leak
- Description: (empty)
- Categories: (empty)
- Analysis Type: Expression Rollup Event Frame Generation SQC
- Enable analyses when created from template:
- Example Element: EnCana\Anadarko\STACK\Equipment\TKWT_EDGAR1H14_01
- Generation Mode: Explicit Trigger
- Event Frame Template: Tank-Leak_USA

The 'Variables' table is as follows:

Name	Expression	True for	Severity
TLVal	'Tank Level'		⊗
TLValPrev	PrevVal('Tank Level','*')		⊗
TLValPrevPrev	PrevVal('Tank Level',PrevEvent('Tani		⊗
TLValT	'*'		⊗
TLValPrevT	PrevEvent('Tank Level','*')		⊗
TLValPrevPrevT	PrevEvent('Tank Level',PrevEvent('T		⊗
TLValDiff	TLValPrev - TLVal		⊗
TLTimeDiff	Int(TLValT - TLValPrevT) / 3600		⊗

The 'Functions' pane on the right shows a list of functions, with 'Abs(number x)' highlighted. The description for 'Abs' is: 'Return the absolute value of an integer or real number. Example: Abs(-2.2) [Returns 2.2]'. The 'Scheduling' section is set to 'Event-Triggered' and 'Trigger on' is set to 'Any Input'.

Tank Level Anomaly

Results

- Tank leaks were identified, and the IOC would notify operations
- Working to reduce false positivity rates as much as possible
- After a few weeks, the algorithm would not only identify tank leaks, but other process anomalies (plugged strainers, underpowered LACTs, leaking check valves, plugged filters, calibration issues, degraded pumps, etc.)
- Realization looking for tank leaks lead to early detection of process anomalies
- Questions started about ‘What other anomalies can we identify before issues occur?’



Rapid Anomaly Detection Begins with Collaboration Ideation

- Multiple team collaboration to create process anomaly ideas and algorithms
- Anomalies would be identified for users, instead of users manually looking for them
- Multiple systems could generate anomalies
- Results to be displayed in a dashboard
- Trending data
- Have people, process and technology in place to rapidly develop anomaly algorithms
- Hybrid technology and "layers of analytics" approach using
 - Collaboration platforms (SharePoint)
 - ETL tools (Azure Data Factory)
 - AVEVA PI System
 - Data engineering (Databricks)
 - Cloud Databases (SQL Server, Synapse)
 - BI / dashboard tools (Power BI)

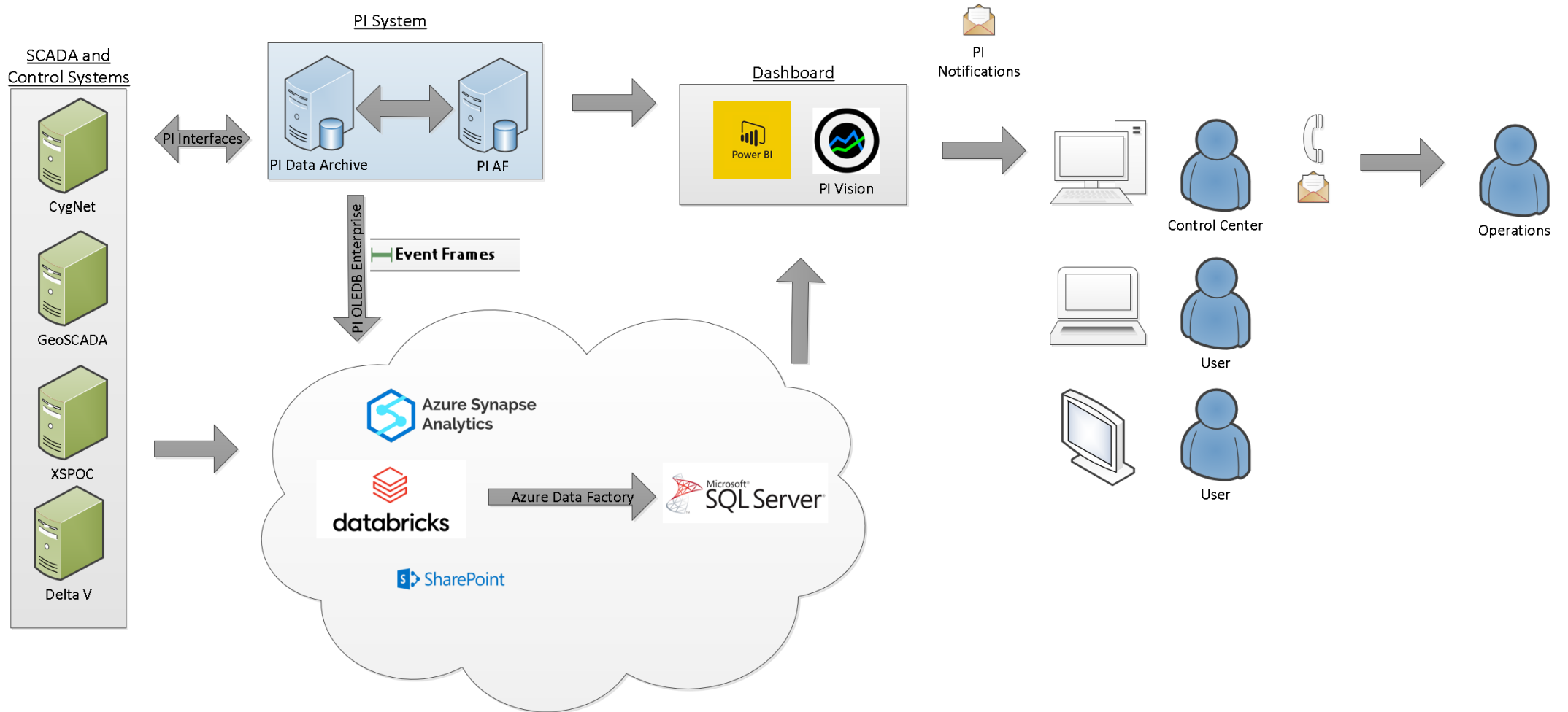


Team Collaboration



A large, light grey circular graphic containing a word cloud of technical terms. The words are arranged in a roughly circular pattern, with "Data Engineering" being the largest and most prominent. Other terms include "Optimization", "Machine Learning", "Automation and Measurement", "Integrated Operations Center", "Production Operations Digital Data", "Operations Data Projects", "Operations Control Center", "Information Technology", "Production Engineering", "Field Operations", and "SCADA". At the bottom of the circle is the logo for "sunLead Technologies", which includes a stylized sun icon and the text "sunLead Technologies".

RAD Data and Process Flow



Defining an Anomaly



SharePoint Search this list

+ New Edit in grid view Share Export Automate Integrate Edit all Copy link

US Process Anomaly Tracker

Anomaly name	Anomaly Code	Algorithm	WIN Criteria
Tank Level Anomaly	USARAD010	3 consecutive SCADA polls in 3 hours Negative slope in the last two hours Tank level declining (no	- Operator finds leak on tank or auxiliary equipment tied to the tank in question - Operator finds
Net Gas Volume Declining	USARAD009	7 day gross sales gas - 7 day gross injection = 7 day net gas Yesterdays sales gas - yesterdays injection =	
ESD Valve Event	USARAD008	ESD permissive sent, gas rate still >0 Anomaly not created if well is down in PA.	
Choked Back	USARAD007	Tubing pressure (2 hour avg) - choke (flowline) pressure (2 hour avg) > 10 psi	
VRU Runtime Declining	USARAD006	VRU runtime decline in the last 24 hours compared to the previous 72 hours by 20%.	Anomaly identifies a VRU that is showing a decline in runtime or erratic status while production remains consistent through facility
Loss of Inflow / Circulating Gas Lift	USARAD005	Injection (4 hour avg)	

Tank Level Anomaly

Anomaly Code
USARAD010

Algorithm
3 consecutive SCADA polls in 3 hours
Negative slope in the last two hours
Tank level declining (no more than an increase of one inch from last poll)...

See more

WIN Criteria
- Operator finds leak on tank or auxiliary equipment tied to the tank in question
- Operator finds partially blocked filter or sub optimal pump/LACT conditions...

See more

Anomaly Owner

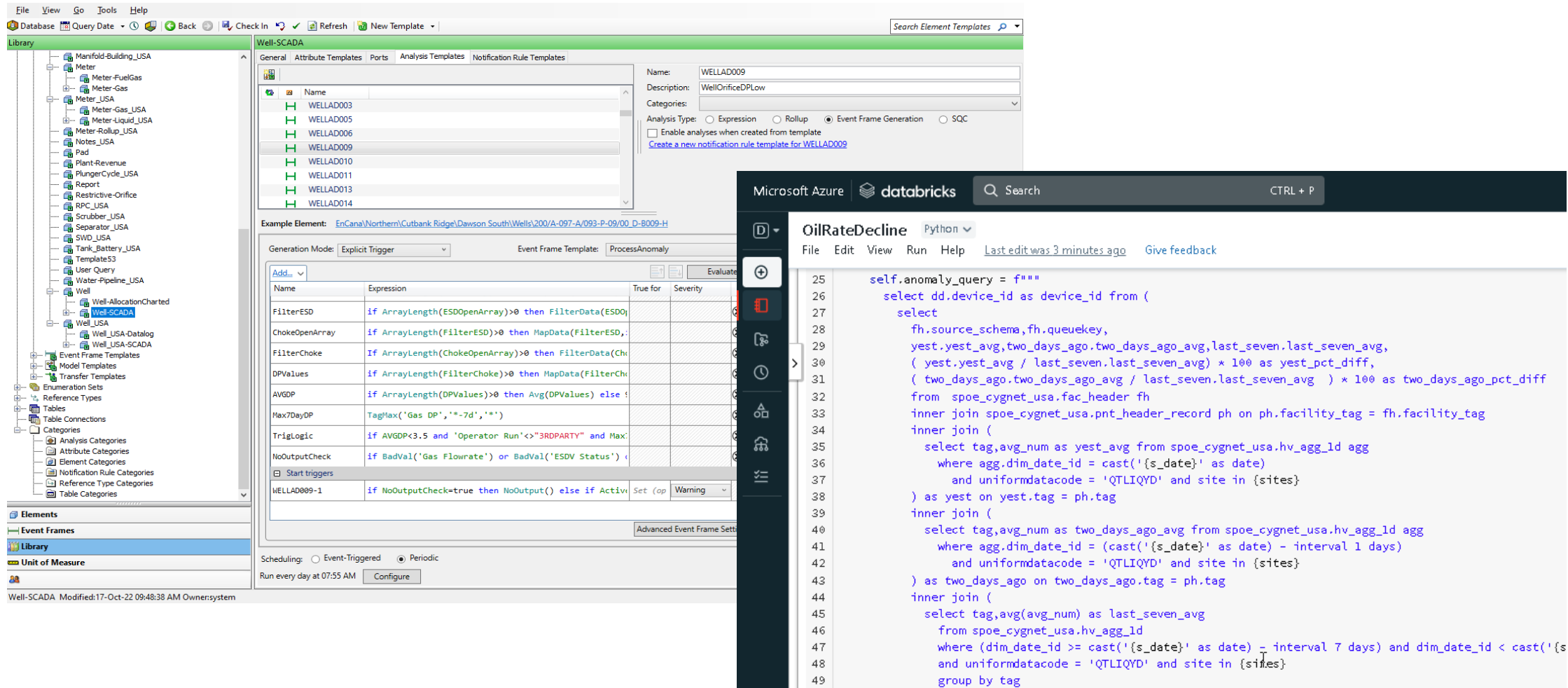
Asset
Anadarko

Anomaly name *
Tank Level Anomaly

Category
Production performance

Subcategory

Building Anomaly Algorithms



The screenshot displays the Ovintiv software interface for building anomaly algorithms. The main window is titled 'Well-SCADA' and shows a configuration panel for an element named 'WELLAD009'. The configuration includes a name, description, and analysis type (Expression, Rollup, Event Frame Generation, or SQC). Below this, a table lists various filters and triggers used in the algorithm.

Name	Expression	True for	Severity
FilterESD	if ArrayLength(ESDOpenArray)>0 then FilterData(ESDQ)		
ChokeOpenArray	if ArrayLength(FilterESD)>0 then MapData(FilterESD,:		
FilterChoke	If ArrayLength(ChokeOpenArray)>0 then FilterData(Chk		
DPValues	if ArrayLength(FilterChoke)>0 then MapData(FilterChk		
AVGDP	if ArrayLength(DPValues)>0 then Avg(DPValues) else !		
Max7DayDP	TagMax('Gas DP', '-7d', '')		
TrigLogic	if AVGDP<3.5 and 'Operator Run'<>"3RD PARTY" and Max:		
NoOutputCheck	if BadVal('Gas Flowrate') or BadVal('ESDV Status') <		
Start triggers			
WELLAD009-1	if NoOutputCheck=true then NoOutput() else if Activi	Set (op	Warning

Below the table, the 'Scheduling' section is set to 'Periodic' with a frequency of 'Run every day at 07:55 AM'. A 'Configure' button is visible.

Overlaid on the right side of the interface is a Databricks notebook titled 'OilRateDecline' in Python. The code defines an anomaly query using SQL:

```

self.anomaly_query = f"""
select dd.device_id as device_id from (
select
  fh.source_schema, fh.queuekey,
  yest.yest_avg, two_days_ago.two_days_ago_avg, last_seven.last_seven_avg,
  ( yest.yest_avg / last_seven.last_seven_avg ) * 100 as yest_pct_diff,
  ( two_days_ago.two_days_ago_avg / last_seven.last_seven_avg ) * 100 as two_days_ago_pct_diff
from spoe_cygnnet_usa.fac_header fh
inner join spoe_cygnnet_usa.pnt_header_record ph on ph.facility_tag = fh.facility_tag
inner join (
  select tag, avg_num as yest_avg from spoe_cygnnet_usa.hv_agg_1d agg
  where agg.dim_date_id = cast('{s_date}' as date)
  and uniformdatacode = 'QTLIQYD' and site in {sites}
) as yest on yest.tag = ph.tag
inner join (
  select tag, avg_num as two_days_ago_avg from spoe_cygnnet_usa.hv_agg_1d agg
  where agg.dim_date_id = (cast('{s_date}' as date) - interval 1 days)
  and uniformdatacode = 'QTLIQYD' and site in {sites}
) as two_days_ago on two_days_ago.tag = ph.tag
inner join (
  select tag, avg(avg_num) as last_seven_avg
  from spoe_cygnnet_usa.hv_agg_1d
  where (dim_date_id >= cast('{s_date}' as date) - interval 7 days) and dim_date_id < cast('{s
  and uniformdatacode = 'QTLIQYD' and site in {sites}
) group by tag

```


RAD Dashboard (Canada)

Ovintiv

COA Rapid Anomaly Detection Dashboard

PROVINCE OPERATING AREA OPERATOR RUN SEVERITY ASSET PRIORITY STATUS ACK

OCC OPTI OPS DATA TEST
All All All All All All All
↶

FILTER BY LOCATION:
Active or Unacknowledged
Inactive or Acknowledged
ANOMALIES: 44,079

ANOMALY	OPERATING AREA	PAD	LOCATION	START TIME	CYGNET FAC	PRIORITY	SEVERITY	TRD	ACTIVE	ACK
Gas Lift Logic Inactive	DAWSON NORTH	TOW 03-09		2022-10-14 08:10	BIS1481_FLW1	PRIORITY 1	4-Major	🔄	ACTIVE	✓
Gas Lift Logic Inactive	PIPESTONE	PIP 06-06		2022-10-14 08:10	SEX3019_FLW1	PRIORITY 1	4-Major	🔄	ACTIVE	✓
Well Not Reaching Buildup...	DAWSON SOUTH	BIS A-085-B		2022-10-14 07:25	BIS0272_FLW1	PRIORITY 1	4-Major	🔄	ACTIVE	✓
Flowing Well Meter Run Blo...	PIPESTONE	PIP 15-02		2022-10-14 06:00	SEX3083_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	★
Optimization Status Chan...	PIPESTONE	PIP 04-02		2022-10-14 06:00	SEX0381_FLW2	PRIORITY 1	3-Minor	🔄	ACTIVE	★
Optimization Status Chan...	TUMBLER	CUT B-051-I		2022-10-14 06:00	CUT1375_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	★
Optimization Status Chan...	TUMBLER	CUT B-097-J		2022-10-14 06:00	CUT1398_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	★
Well Not Reaching Buildup...	DAWSON SOUTH	BIS A-017-G		2022-10-14 05:25	BIS0148_FLW4	PRIORITY 1	4-Major	🔄	INACTI...	★
Possible Highline Restriction	PIPESTONE	PIP 15-26		2022-10-14 04:08	SEX3070_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	✓
Well Not Reaching Buildup...	DAWSON SOUTH	BIS B-005-G		2022-10-14 03:25	BIS0146_FLW3	PRIORITY 1	4-Major	🔄	INACTI...	✓
New Gas Lift Usage	DAWSON NORTH	TOW 02-12		2022-10-14 02:45	BIS1119_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	✓
New Gas Lift Usage	DAWSON NORTH	TOW 03-09		2022-10-14 02:45	BIS1482_FLW1	PRIORITY 1	3-Minor	🔄	INACTI...	✓
Well Not Reaching Buildup...	DAWSON SOUTH	BIS A-088-A		2022-10-14 02:25	BIS0138_FLW3	PRIORITY 1	4-Major	🔄	ACTIVE	✓
Gas Lift Choke Closed with...	PIPESTONE	PIP 06-06		2022-10-14 02:20	SEX3019_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	★
Dual Meter Run Well Vol Dif...	DAWSON NORTH	SAT 13-33		2022-10-14 02:04	BIS1510_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	✓
Dual Meter Run Well Vol Dif...	DAWSON NORTH	SAT 04-24		2022-10-14 02:03	BIS1559_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	✓
Excessive Choke Travel	PIPESTONE	PIP 04-31		2022-10-13 23:55	SEX3126_FLW1	PRIORITY 1	4-Major	🔄	INACTI...	✓
Excessive Choke Travel	PIPESTONE	PIP 04-31		2022-10-13 23:55	SEX3053_FLW1	PRIORITY 1	4-Major	🔄	INACTI...	✓
Check Gas Lift MVT	DAWSON SOUTH	BIS 06-22		2022-10-13 23:50	BIS1236_FLW1	PRIORITY 1	4-Major	🔄	INACTI...	✓
New Gas Lift Usage	PIPESTONE	PIP 16-27		2022-10-13 23:45	SEX3114_FLW1	PRIORITY 1	3-Minor	🔄	INACTI...	✓
Gas Lift Choke Open no Flo...	PIPESTONE	PIP 15-26		2022-10-13 23:10	SEX3065_FLW1	PRIORITY 1	4-Major	🔄	ACTIVE	✓
Check Comp Capacity Co...	PEACE RIVER ARCH			2022-10-13 22:28	HYT8005	PRIORITY 1	4-Major	🔄	INACTI...	✓
Check Gas Lift MVT	PIPESTONE	PIP 06-06		2022-10-13 20:50	SEX3091_FLW1	PRIORITY 1	4-Major	🔄	ACTIVE	✓
Check Gas Lift MVT	PIPESTONE	PIP 14-27		2022-10-13 20:50	SEX3160_FLW1	PRIORITY 1	4-Major	🔄	INACTI...	✓
Possible Highline Restriction	DAWSON NORTH	TOW 01-05		2022-10-13 20:08	BIS1335_FLW1	PRIORITY 1	3-Minor	🔄	ACTIVE	✓
Check Comp Capacity Co...	PEACE RIVER ARCH			2022-10-13 19:28	HYT8005	PRIORITY 1	4-Major	🔄	INACTI...	✓

● WIN ● VALID ● INVALID

Enter comments here...

Acknowledge
Cancel

* Click to sign-in to PowerApps, if required

SELECT ANOMALY

- Well Meter Below Cutoff 4,188
- Optimization Status Change 3,347
- Gas Lift Choke Closed with ... 2,962
- Passing Choke 2,955
- Loaded Well - Not Flowing 2,645
- Meter Run Needs Blowdown 2,517
- Flowing Well Meter Run Blo... 2,192
- RTU Voltage 2,028
- Well Not Reaching Buildup ... 1,928
- Check Pad Flows 1,451
- Possible Highline Restriction 1,445
- Gas Lift Choke Open no Flow 1,381

RAD Dashboard (USA)

US RAD

1/30/2022 10/17/2022
Last 30 Days
Prod Test
Last data load
10/14/2022 2:08:15 PM

Basin Area Route Rank Severity Ack Group Anomalies 3351

All All All All All All IOC

Active and Unacknowledged Inactive or Acknowledged Tracked New

	Basin	Area	Route	Device	Rnk	Anomaly	Trd	Start Time	Grp	Ack	Trk	Sta
Critical	Bakken	Westberg	Route 01		NA	Sustained Production Flare		9/15/2022 4:00:11 PM	IOC	✓		
Critical	Bakken	Westberg	Route 02		NA	Sustained Production Flare		9/15/2022 4:00:11 PM	IOC	✓		
Warning	Permian	East	Route 03		NA	High Frequency Alarm Ano...		9/15/2022 4:03:49 PM	IOC			
Warning	Bakken	Watford	Route 02		A	Sustained Oil Rate Decline		9/15/2022 4:03:51 PM	IOC	✓		
Warning	Permian	South	Route 02		A	Separator- Tubing Different...		9/15/2022 5:00:05 PM	IOC	★		●
Warning	Anadarko	Stack South	Route 02		C	Plunger Well No Flow		9/15/2022 5:00:22 PM	IOC	★		●
Warning	Permian	South	Route 06		NA	Level Transmitter Spiking		9/15/2022 6:00:01 PM	IOC	★		●
Critical	Anadarko	Stack North	Zone 03		NA	Flare Pilot Outage		9/15/2022 6:00:10 PM	IOC	✓		●
Critical	Bakken	Lost Bear	Route 02		NA	Sustained Production Flare		9/15/2022 6:00:11 PM	IOC			●
Critical	Permian	North	Route 05		NA	Sustained Production Flare		9/15/2022 6:00:11 PM	IOC	✓		●
Warning	Permian	East	Route 02		NA	High Frequency Alarm Ano...		9/15/2022 6:05:20 PM	IOC	✓		●
Warning	Permian	East	Route 05		A	High Frequency Alarm Ano...		9/15/2022 6:05:20 PM	IOC	✓		●
Warning	Permian	North	Route 07		A	ESP Offline		9/15/2022 6:09:00 PM	IOC	★		●
Critical	Anadarko	Scoop South	Route 01		NA	Tank Level Anomaly		9/15/2022 6:27:28 PM	IOC	✓		●
Critical	Anadarko	Scoop South	Route 01		NA	Tank Level Anomaly		9/15/2022 6:42:18 PM	IOC	✓		●
Warning	Anadarko	Stack South	Route 04		B	Plunger Lift - Arrival Time d...		9/15/2022 6:52:00 PM	IOC	✓		●
Critical	Anadarko	Stack South	Route 04		NA	Sustained Production Flare		9/15/2022 7:00:11 PM	IOC	✓		●
Critical	Permian	North	Route 04		NA	Sustained Production Flare		9/15/2022 7:00:11 PM	IOC	✓		●
Warning	Permian	South	Route 08		A	Plunger Well No Flow		9/15/2022 7:00:22 PM	IOC			●
Warning	Bakken	Lost Bear	Route 02		A	Sustained Oil Rate Decline		9/15/2022 7:04:19 PM	IOC	✓		●
Warning	Permian	East	Route 03		B	ESP Pump Intake		9/15/2022 7:08:00 PM	IOC	✗		●
Warning	Permian	East	Route 02		A	ESP Well No Flow		9/15/2022 8:00:20 PM	IOC	★		●

Please select an anomaly...

 Win
 Valid
 Invalid
 Track

Enter comments here...

Acknowledge
Cancel

Anomaly Name

Search

- Flare Pilot Outage 347
- Sustained Production Flare 343
- Tank Level Anomaly 241
- Gas lift - Casing Pressure Dev... 202
- Plunger Well No Flow 194

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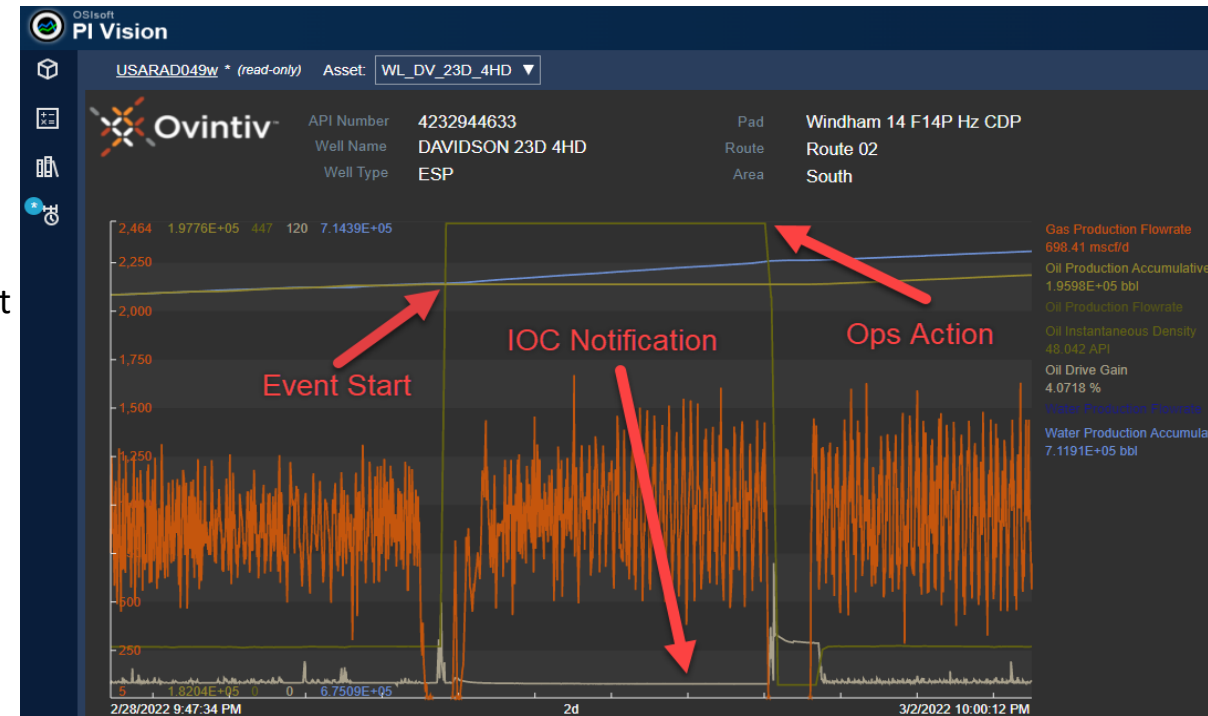
[Anomaly definition list](#)
[Task tracker list](#)

 Icon Legend

Separator Health

Problem

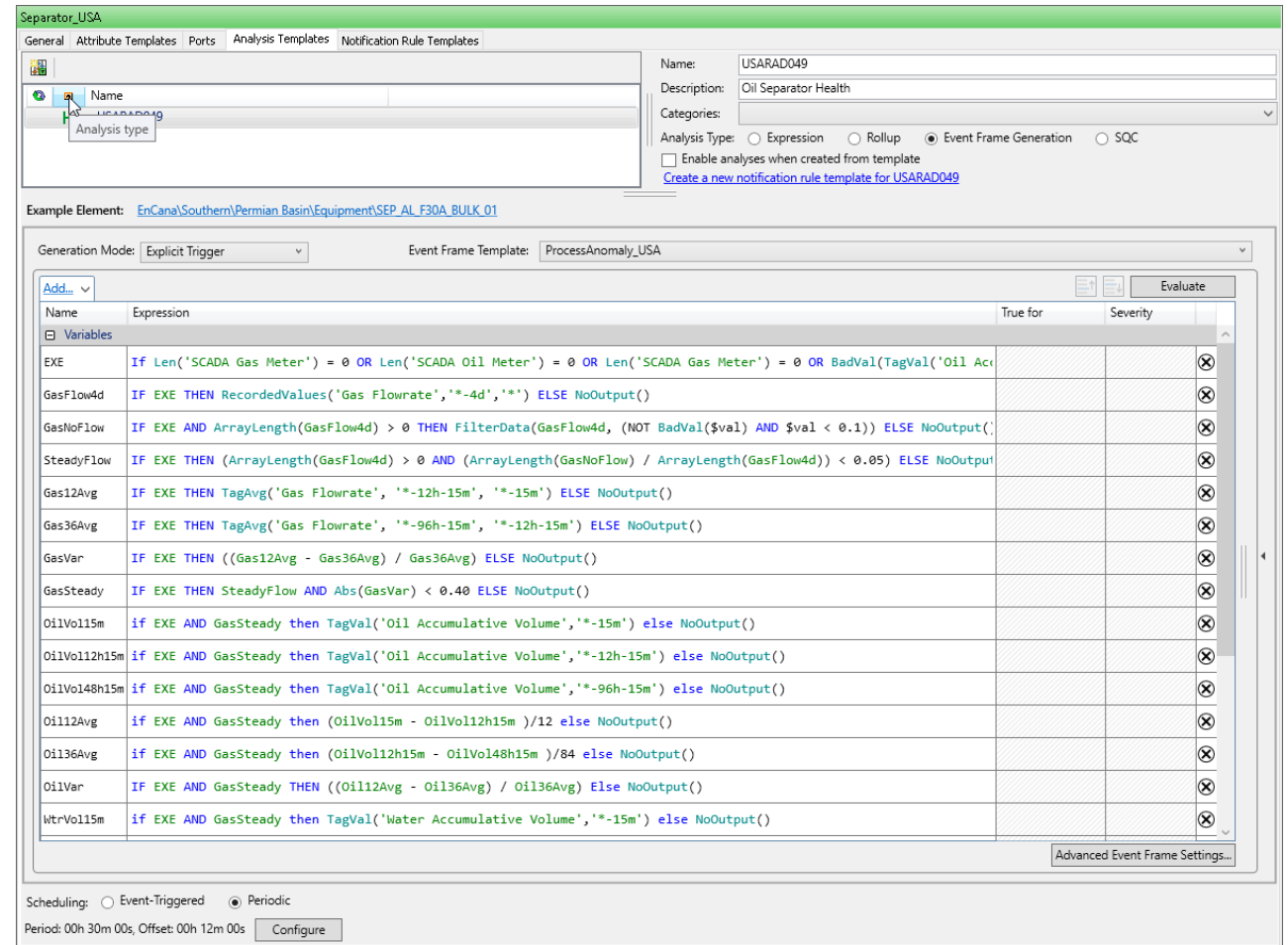
- Anomaly targets upsets in our separation equipment to help avoid allocation issues and the additional cost associated with removing incorrect liquid phase from our dedicated tanks
- Cost associated with incorrect allocation can be recaptured through allocation correction and sundry approval but requires dedicated time from production accounting and engineering
 - Most commodity cost lost to outside third-party disposal companies is not recovered
- Cost associated with potential skimming, chem treatment (demulsification agent) and truck hauling listed below and will be what wins are associated with
- Cost estimate to recover upset volumes varied from ~ \$1.00-\$2.00/bbl.
- Previous time estimates for upset to be noticed varied between ~6 hours-3 days
- Average time to notify and resolve issue will be calculated at 6 hours



Separator Health Analytics

Algorithm logic

- 12 hours compared to previous 48 hours
- Gas rate is steady (40%)
- 20% increase in oil with 20% decrease in water OR 20% increase in water with 20% decrease in oil
- Exclude test separators
- Gas flow rate must not be 0 for 95% of the polled values in the last 4 days
- No communication outages when using accumulators to calculate volumes/rate
- Sustained for more than 6 hours
- Running every 30 minutes on every separator asset



The screenshot shows the configuration for 'Separator_USA' with the following details:

- Name:** USARAD049
- Description:** Oil Separator Health
- Analysis Type:** Event Frame Generation
- Example Element:** EnCana/Southern/Permian Basin/Equipment/SEP_AL_F30A_BULK_01
- Generation Mode:** Explicit Trigger
- Event Frame Template:** ProcessAnomaly_USA

Name	Expression	True for	Severity
EXE	IF Len('SCADA Gas Meter') = 0 OR Len('SCADA Oil Meter') = 0 OR Len('SCADA Gas Meter') = 0 OR BadVal(TagVal('Oil Acc...		⊗
GasFlow4d	IF EXE THEN RecordedValues('Gas Flowrate', '*-4d', '**') ELSE NoOutput()		⊗
GasNoFlow	IF EXE AND ArrayLength(GasFlow4d) > 0 THEN FilterData(GasFlow4d, (NOT BadVal(\$val) AND \$val < 0.1)) ELSE NoOutput()		⊗
SteadyFlow	IF EXE THEN (ArrayLength(GasFlow4d) > 0 AND (ArrayLength(GasNoFlow) / ArrayLength(GasFlow4d)) < 0.05) ELSE NoOutput()		⊗
Gas12Avg	IF EXE THEN TagAvg('Gas Flowrate', '*-12h-15m', '*-15m') ELSE NoOutput()		⊗
Gas36Avg	IF EXE THEN TagAvg('Gas Flowrate', '*-96h-15m', '*-12h-15m') ELSE NoOutput()		⊗
GasVar	IF EXE THEN ((Gas12Avg - Gas36Avg) / Gas36Avg) ELSE NoOutput()		⊗
GasSteady	IF EXE THEN SteadyFlow AND Abs(GasVar) < 0.40 ELSE NoOutput()		⊗
OilVol15m	if EXE AND GasSteady then TagVal('Oil Accumulative Volume', '*-15m') else NoOutput()		⊗
OilVol12h15m	if EXE AND GasSteady then TagVal('Oil Accumulative Volume', '*-12h-15m') else NoOutput()		⊗
OilVol148h15m	if EXE AND GasSteady then TagVal('Oil Accumulative Volume', '*-96h-15m') else NoOutput()		⊗
Oil12Avg	if EXE AND GasSteady then (OilVol15m - OilVol12h15m) / 12 else NoOutput()		⊗
Oil36Avg	if EXE AND GasSteady then (OilVol12h15m - OilVol148h15m) / 84 else NoOutput()		⊗
OilVar	IF EXE AND GasSteady THEN ((Oil12Avg - Oil36Avg) / Oil36Avg) ELSE NoOutput()		⊗
WtrVol15m	if EXE AND GasSteady then TagVal('Water Accumulative Volume', '*-15m') else NoOutput()		⊗

Scheduling: Event-Triggered Periodic
 Period: 00h 30m 00s, Offset: 00h 12m 00s Configure

Anomaly List

180+ anomalies currently monitored in Canada and USA

10 Consecutive Missed Plunger Arrivals	ESD Valve Fail To Close	GL Differential Pressure Spiking	Pipeline SWD Underutilization	Sustained Missed Plunger Arrivals
15-30 PLH Inlet Velocity Monitor	ESD Valve Fail To Open	GL Manual Override Enabled	Plunger Details Need Review	Sustained Oil Rate Decline (DH)
Acid Gas Comp Recycle Valve Passing	ESP Drive Current	GL Meter Below Cutoff	Plunger High Average Velocity	Sustained Production Flare
Acid Gas Pump Output Reduction	ESP Frequency	GL Valve Actuator Failure	Plunger Lift - Arrival Time deviation	Sustained Production Flare Event
Amine Filter DP Not Increasing	ESP Hz Increase	GL Valve Rate Limited/Frozen	Plunger MFSP High	Tank Level Anomaly
Arrival Sensor Failed	ESP Motor Current	GL Variable Flow Opportunity	Plunger Replacement Frequency Missing	Tank Level Anomaly (Uinta)
Building Heat Out	ESP Motor Temperature	H2S Content Increased	Plunger Stopped Freecycling	Tank Set Point Health
Buyback Meter Failed ESD	ESP Offline	Heater Treater High Sustained Temperature	Plunger Wear	TGLS Comp Multi Variable Review
Casing Pressure Deviation	ESP Pump Intake	High Density Potentially Not Setup	Plunger Well No Flow	Tower Plant - Operating in Hydrate Region
Check Comp Capacity Controls	ESP Total Fluid	High Frequency Alarm Anomaly	Plunger Well without Max SD Enabled	Update Artificial Lift Type- Blank
Check Gas Lift MVT	ESP Tubing Pressure Increase	High Rate Well Drawdown Monitoring	Possible Choke Wear MVT DP	Update Artificial Lift Type- GL On
Check Pad Flows	ESP Well No Flow	Hydrate Shutdown Wells	Possible Debris Catcher Plugged	Update Artificial Lift Type- Mismatch
Check Plunger Sharepoint Info	Excessive Choke Travel	Ifpexol Not Dumping	Possible Frozen Well	Update CSG FLW to TBG FLW
Check Stabilizer Setpoints	Exchanger Controls Check	Incorrect ESD Reason Code - Flowing Well	Possible frozen Wellhead PT	Update GL Design
Check Tubing or Casing Size	Expected Flow Well Not Flowing	Inlet Sep Hydrate Forming	Possible frozen Wellhead PT - High	Update Lift Detail
Choke Flow LL Disable Possible	Failed ESD	Jet lift Well No Flow	Possible Highline Restriction	VRU Runtime Declining
Choked Back Jet Pumps	Fast Plunger using Gas Lift	Jet Pump Power Fluid Rate Decline	Possible Packing Issue	Well H2S Detection Drifting Up
Comp Valve Discharge Temp Deviation	Flare LP Mass Meter Rate Spike	Left to Right Bank Manifold Compare	Possible Under Performing Well	Well Left in Manual
Compressor Lubricator Rate Change	Flare Pilot Outage	Level Transmitter Spiking	Potential Block Valve Voltage Issue	Well LEL Detection Drifting Up
Compressor Oil Pressure Declining	Flow Setpoint Changed	Level Transmitters COM Health	Pump Barrier Pressure Monitoring	Well Loading, Casing Pressure Increasing
Compressor Vibration Increasing - Long Term	Flow with Choke or ESD Closed	Loading Well - Csg Flow	Reset Plunger Mileage	Well Meter Below Cutoff
Compressor Vibration Increasing - Short Term - Electric Drive	Flowing Well Meter Blowdown Req'd - Non GL Wells	Loading Well - GL Well	Restricted Orifice DP Change	Well Near High Temp SD
Compressor Vibration Increasing - Short Term - Gas Drive	Flowing Well Meter Run Blowdown Req'd - GL Wells	Loading Well - Tbg Flow	Review Plunger Max SD's	Well Near Low Temp SD
CSG FLW Well - Possible Tubing Install	Frac Watch	Louvres out of Range	RPC Well No Flow	Well Needs Local Reset
D-064-I/ C-042-G FG Step Change	GAPL Well Wrong Mode	Lower Pressure Override	RTU Voltage	Well Not Flowing - Downhole Issue
Decommissioned/Offline LACT	Gas lift - Casing Pressure Deviation	Main Bearing Temp Deviation	SCADA Suite Plunger Mode Disabled	Well Not Reaching Buildup SP
Disable Edge Sour Logic	Gas Lift Choke Closed with Flow - GL in Use	Max Flow Setpoint Exceeded	SCADA Suite Plunger Mode Enabled	Well Not Reaching Buildup SP-CUT
Dual Meter Choke Variance	Gas Lift Choke Closed with Flow - GL Not in Use	Mechanical Auxiliary Issue	SCADASuite Froze	Well O/P Change Required
Dual Meter Run Well Vol Diff High	Gas Lift Choke Open no Flow	Meter Run Needs Blowdown - Cycle Flowing Well	Separator Health	Well Short Cycling
Elevated Tank Vapor Pressure	Gas Lift Inactive	Meter Run Needs Blowdown - Fully Flowing Wells	Separator-Line Differential Pressure	Well Status Update Req'd
Enable Edge Sour Logic	Gas Lift Logic Enabled With No GL Mode	Negative DP- Check Meter or Blowdown Meter	Separator-Tubing Differential Pressure	Well Stuck In Buildup
Engine Low Jacket Water Warning	Gas Lift Logic Inactive	New Gas Lift Usage	Setup OPTI	Well Throttling
Engine Oil Pressure Declining	Gas Lift MVT Override	No Derived Arrival	SOR Comm Fail	Well Waxing Off
Engine Pyro Issues	Gas lift not on bottom valve	Optimization Enabled and Not Running	SOR to MR DP	
Engine Vibration Increasing - Long Term	Gas Lift Recycling	Optimization Status Change - OCC	Stabilizer Reboiler Below Setpoint	
Engine Vibration Increasing - Short Term - Electric Drive	Gas Lift Well Over Injecting	Optimization Status Change - OPTI	Stabilizer Reboiler Fouling	
Engine Vibration Increasing - Short Term - Gas Drive	Gas Lift Wells Recycling Gas	Passing Choke	Sustained Gas Rate Decline	

Cost Savings

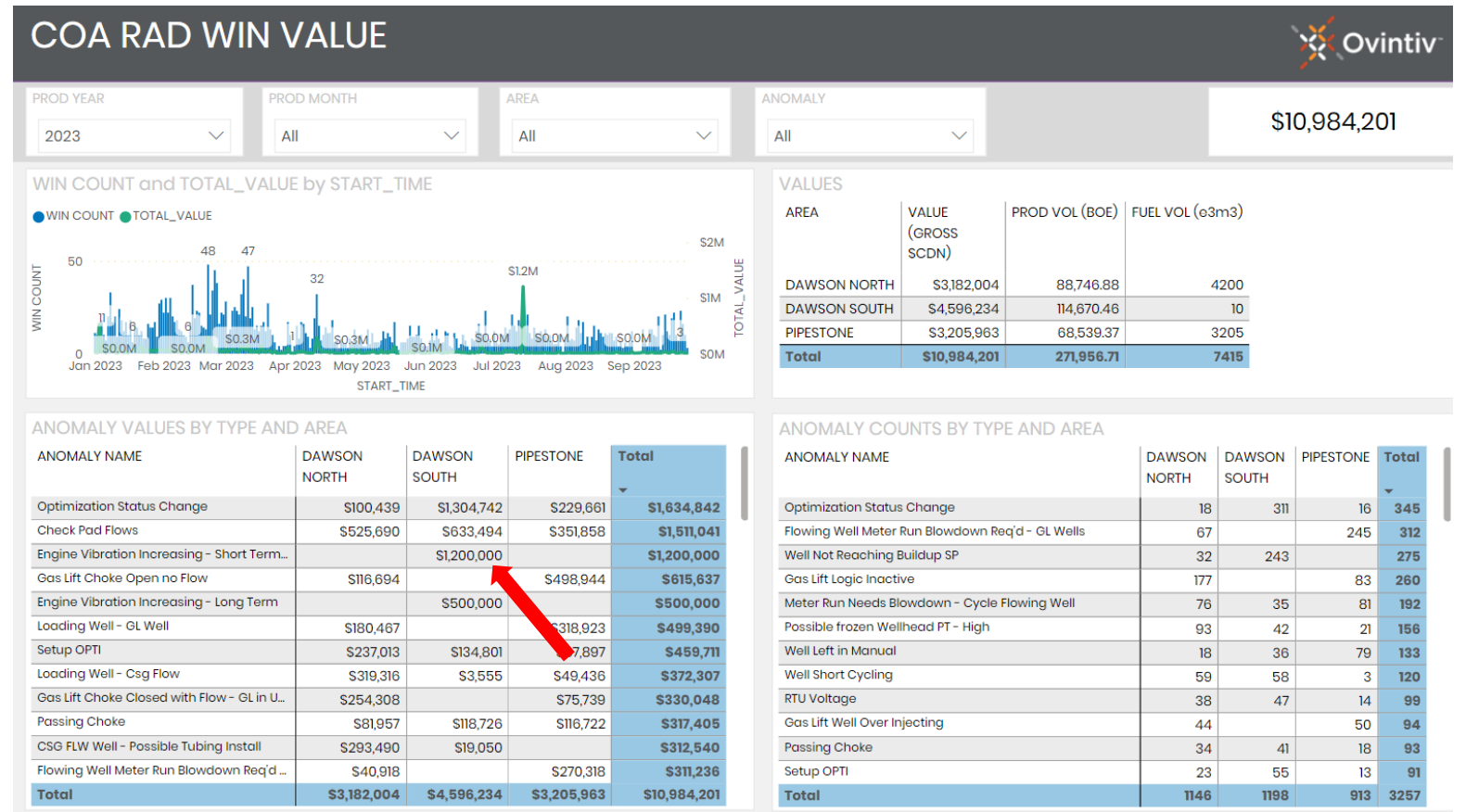
2023 YTD (end of September)

Canada & USA – millions

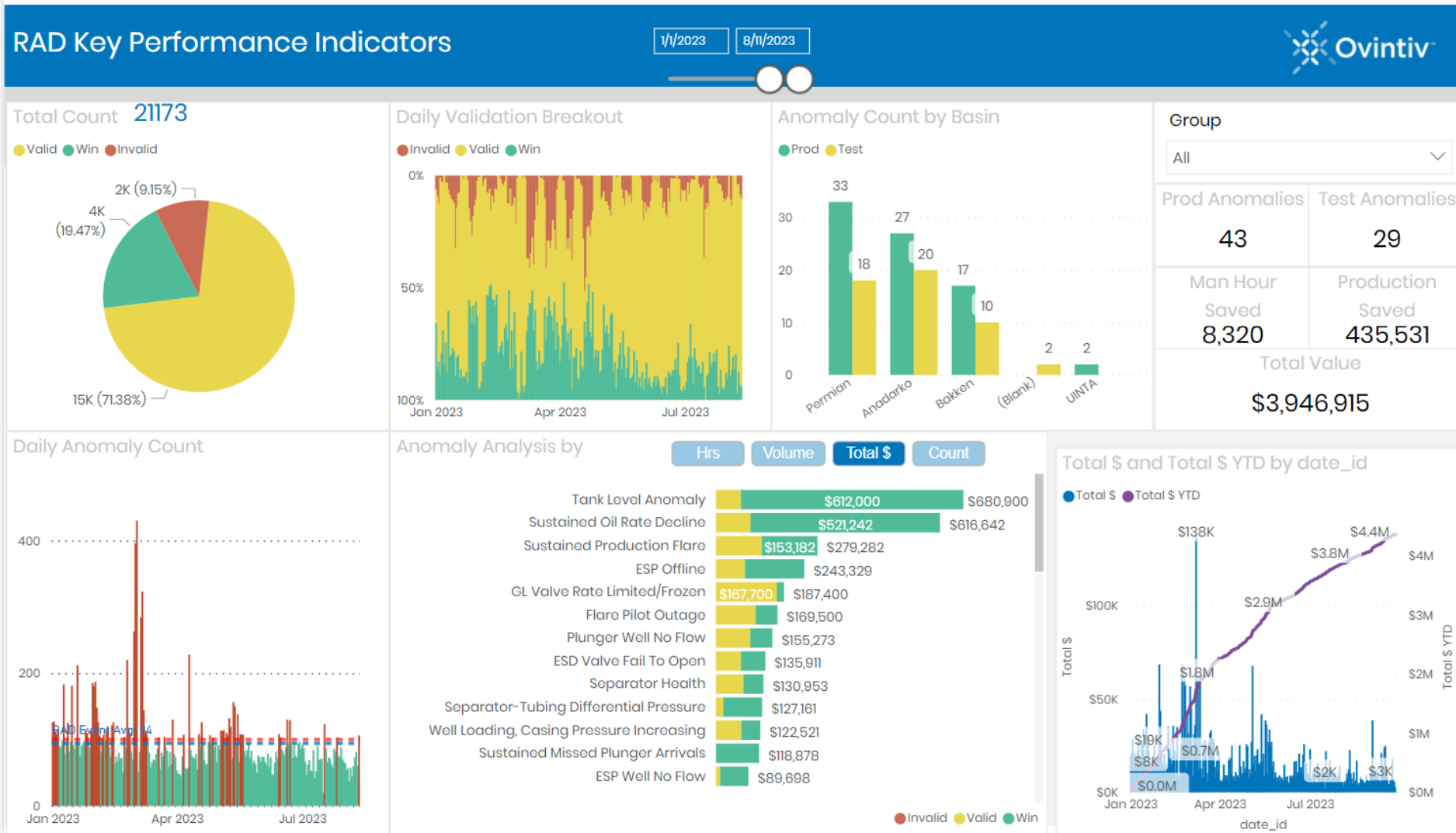
- Production increase
- Production loss avoided
- Gas lift saved
- People hours saved
- Reduced equipment failures and replacement
- Reduced spill volumes
- Static dollar value

Notes:

- Cost savings are estimated
- Challenges in estimating true costs
 - Anomalies might be caught manually processes in a slower amount of time
 - True impact may vary if left unaddressed



KPIs



RAD Lessons Learned

Learning from our experience

- Tuning and refinement is biggest key to developing a successful anomaly
 - Too many anomalies or false positives can lead to missing actual events
- Drive accountability to a small subset of individuals to take ownership of certain anomalies to see the tuning process all the way through
- Define metrics of what is acceptable for users for daily anomaly counts
- Implement a feedback loop to assist tuning of anomalies
- Strong collaboration with a cross-functional team
- Start small with a few anomalies to establish process and procedures
 - Too many anomalies at once can be overwhelming for end users
- Focus on the target user group requirements

Future Plans

The journey continues...

- Continual addition of new anomalies and refinement of current anomalies
- Tying in more data sources to create anomalies
- Phase out anomalies where operational effectiveness eliminated the original anomaly (ie. process improvements)
- Expand to different user groups
 - Production engineering for surveillance and workflow efficiency
- Anomaly suppression
- Further integration of machine learning anomalies

“Rapid Anomaly Detection has allowed Ovintiv’s operations teams to **expedite our digital transformation.**”

Utilizing the AVEVA PI System, we **leverage multivariable event confirmation** in real time **eliminating the need for our team to ‘hunt’ these opportunities.** This in turn allows us to focus on the right opportunities as they emerge reducing overall negative operational impact which **drives value directly to the bottom line!**”

-Tanner Messer (former) Ovintiv Manager, Integrated Operations Center

Enabling Rapid Anomaly Detection with Layers of Analytics

“Rapid Anomaly Detection has allowed Ovintiv’s operations teams to expedite our digital transformation.

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-Tanner Messer (Ovintiv) Manager, Integrated Operations Center

ANOMALY	OPERATING AREA	IAD	LOCATION	START TIME	CHIMNEY FAC	PRIORITY	SEVERITY	TEND	ACTIVE	ACK
Shell US Anomaly	OPERATION SOUTH	08-A-080-A	08-01-070-0800-000-001-A	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-B	08-01-070-0800-000-001-B	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-C	08-01-070-0800-000-001-C	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-D	08-01-070-0800-000-001-D	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-E	08-01-070-0800-000-001-E	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-F	08-01-070-0800-000-001-F	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-G	08-01-070-0800-000-001-G	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-H	08-01-070-0800-000-001-H	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-I	08-01-070-0800-000-001-I	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-J	08-01-070-0800-000-001-J	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-K	08-01-070-0800-000-001-K	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-L	08-01-070-0800-000-001-L	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-M	08-01-070-0800-000-001-M	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-N	08-01-070-0800-000-001-N	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-O	08-01-070-0800-000-001-O	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-P	08-01-070-0800-000-001-P	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-Q	08-01-070-0800-000-001-Q	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-R	08-01-070-0800-000-001-R	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-S	08-01-070-0800-000-001-S	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-T	08-01-070-0800-000-001-T	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-U	08-01-070-0800-000-001-U	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-V	08-01-070-0800-000-001-V	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-W	08-01-070-0800-000-001-W	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-X	08-01-070-0800-000-001-X	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-Y	08-01-070-0800-000-001-Y	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓
Shell US Anomaly	OPERATION SOUTH	08-A-080-Z	08-01-070-0800-000-001-Z	2022-10-10 08:00:00	SEK0000_FURN	PRIORITY 1	3.0	%	ACTIVE	✓

Challenge

- Reactive to operational issues
- Significant lost opportunity costs
- Wasted time looking for information and trying to determine causality
- Challenges in establishing a collaborative environment

Solution

- Leveraged the PI System and PI AF to provide streaming anomaly detection
- Used a multi-technology approach across a hybrid cloud with “layers of analytics”
- Focused on developing a collaborative culture in defining anomalies and approaches
- Evolved and created a “learning” algorithm to refine RAD and minimize false detection
- Facilitated empowering and enabling the SMEs to continue to develop and evolve RAD

Benefits

- Moved from a reactive to a proactive, exception-based culture
- Increased the time to focus, identify and capture higher value opportunities
- YTD savings
 - millions in Canadian & USA operations



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Questions?

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State your name and company.



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