Unveiling Insights: Exploring Anomalies in Utility Monitoring Systems

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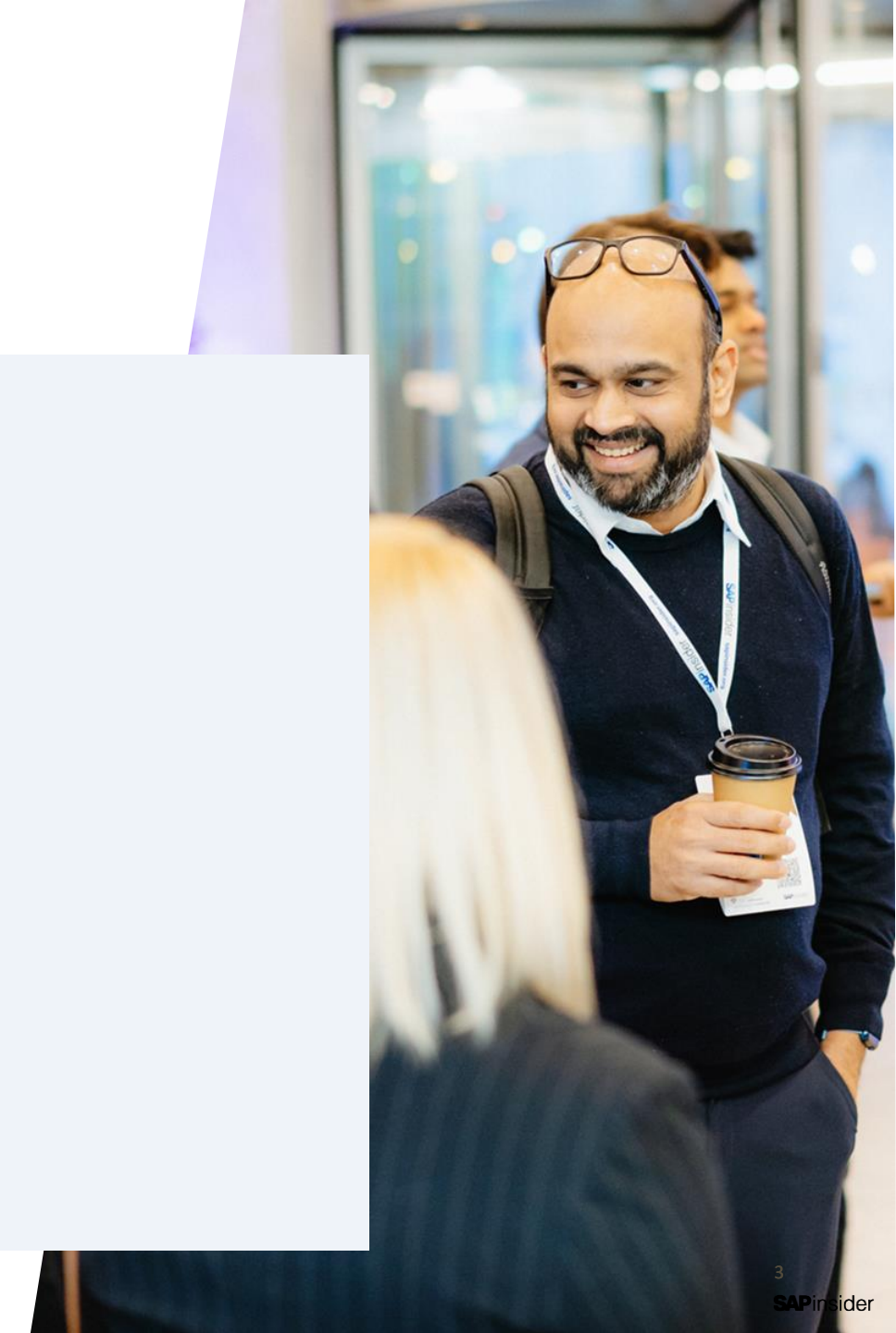
SAPinsider

In This Session

We'll learn how Southwest Gas utilizes SAP Analytics Cloud to identify anomalies in their utility monitoring systems. we'll concentrate on interpreting meter data to ensure accuracy. Southwest Gas aims to simplify the process of detecting and addressing issues by employing SAP Analytics Cloud, which aids in identifying problems and providing valuable insights, ultimately improving the reliability of the utility monitoring.

What We'll Cover

- Introduction
- Overview of GAS Utility Monitoring Systems
- Common Types of Anomalies & Importance
- Challenges in Anomaly Detection
- Detecting Anomalies
- Responding to Anomalies
- Prevention Methods
- SAP Solutions for Anomaly Detection
- Implementation Strategies
- Benefits
- Demo
- Wrap Up



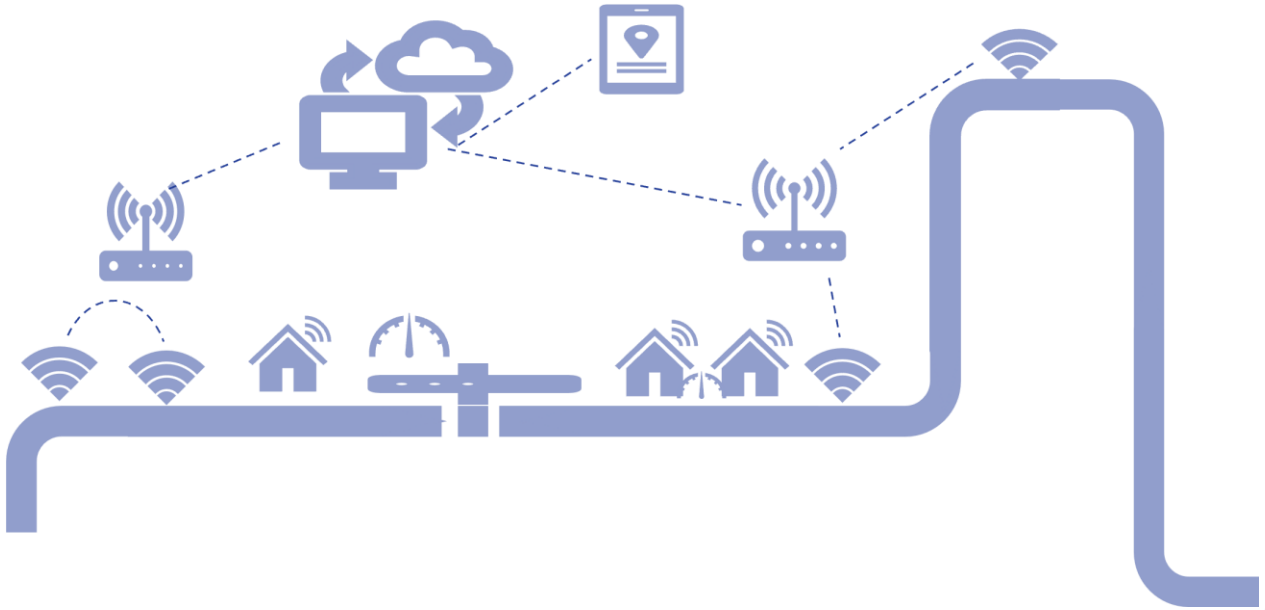
Introduction

Utility monitoring systems are essential for efficient energy management, ensuring reliable services like electricity, gas, and water delivery. They offer real-time insights into consumption, infrastructure performance, and customer behavior.

Today, we'll explore their critical importance, enabling utilities to optimize resources, enhance reliability, and meet regulations. We'll also discuss challenges and innovative solutions shaping the future of energy management. Join us as we uncover the vital role of utility monitoring systems in shaping a sustainable energy landscape.

Overview of GAS Utility Monitoring Systems

GAS utility monitoring systems play a critical role in ensuring safe and reliable gas delivery. They involve sensors, meters, and infrastructure to monitor gas flow, pressure, quality, and consumption. Timely detection of anomalies helps avoid disruptions, ensure compliance, and protect public safety.



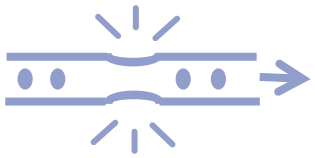
Types of Anomalies

Sudden fluctuations in gas pressure and abrupt changes in flow rates hint at potential leaks or distribution irregularities. Tampering with gas meters risks inaccurate billing and safety hazards. Unexpected alterations in gas composition, like contaminants, can compromise system performance. Equipment malfunctions, such as sensor failures, lead to inaccurate data and system downtime. Non-compliance with safety regulations, including mishandling equipment, poses significant safety risks.

Types of Anomalies & Importance

Leaks

Leakages in pipes due to corrosion, cracks, loose joints or material failures



Blockages

Blockages in pipes due to sedimentation, scaling, debris accumulation or restricted flow

fluctuations

Abnormal changes in gas pressure due to equipment failure, control issues or demand spikes

Theft

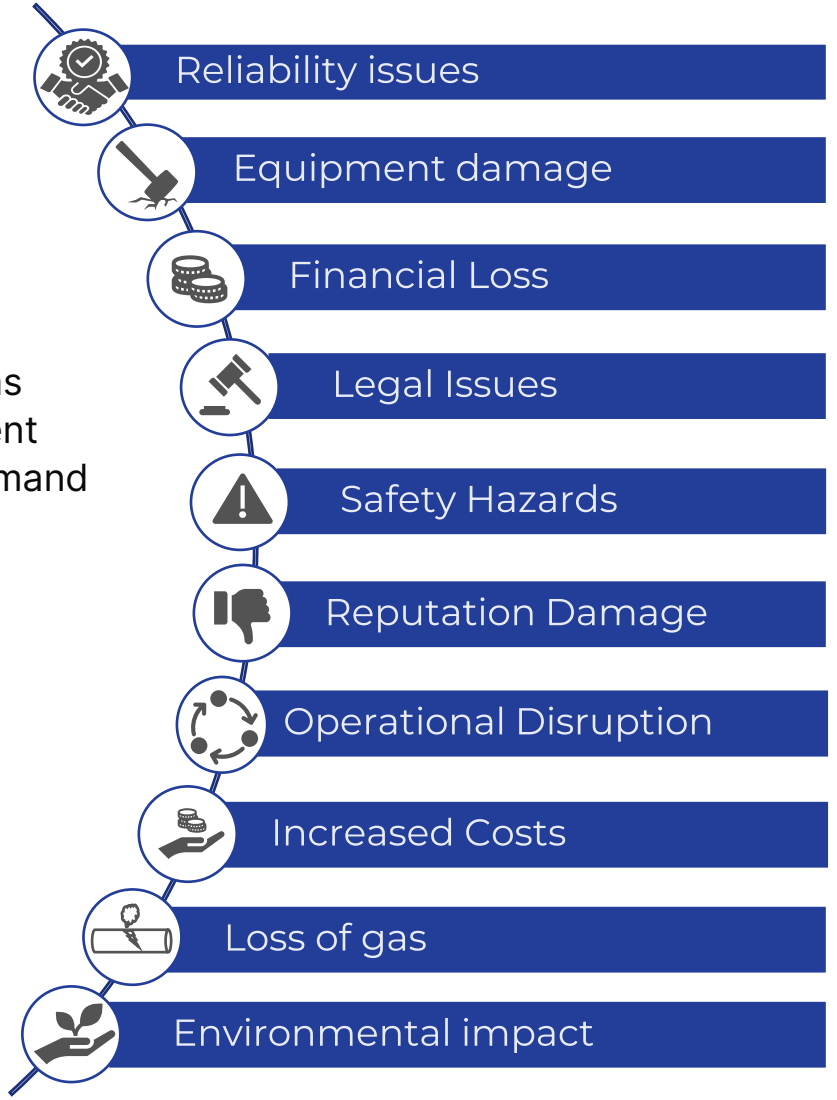
When utility service is obtained illegally without paying.

Meter Tampering

When a meter has been physically tampered with or bypassed.

Equipment

When equipment such as meters fail or malfunction.



Detecting and addressing anomalies in gas systems quickly is crucial for safety, efficiency and service reliability.

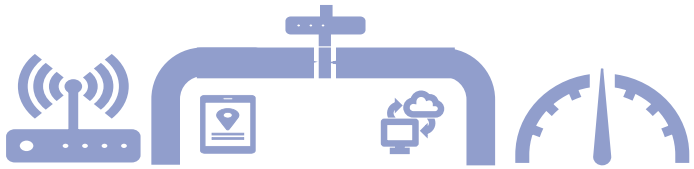
Challenges in Anomaly Detection

Challenges in anomaly detection include distinguishing between normal and abnormal behavior, dealing with noisy data, adapting to evolving patterns, handling imbalanced datasets, and scaling algorithms to large datasets efficiently. Additionally, anomaly detection often requires domain expertise and may face interpretability issues, especially with complex algorithms

Challenges in Anomaly Detection

Complex infrastructure

Vast network of pipelines, meters, sensors makes monitoring difficult.



Limited visibility

Data silos in various systems limit holistic views, while data streams evolve continuously.

Data quality issues

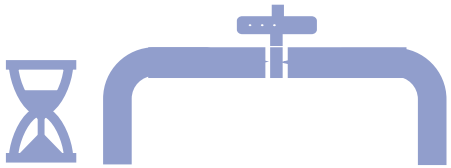
Incomplete or inaccurate data affects reliability, while algorithms face challenges due to high computational complexity

Regulatory requirements

Compliance with safety and reporting regulations.

Aging infrastructure

Outdated components prone to anomalies and failures.



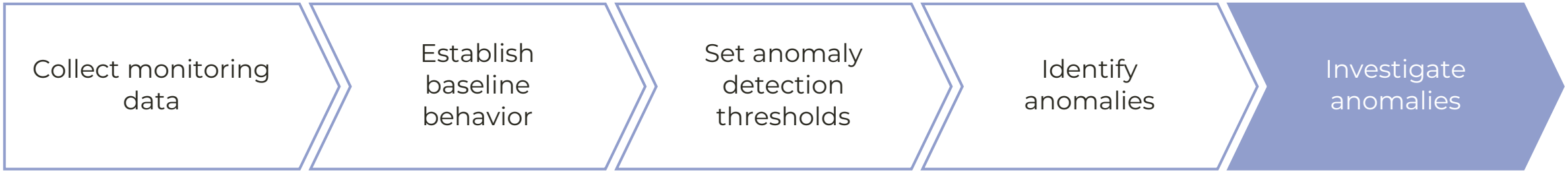
Cybersecurity risks

Potential for external attacks on monitoring systems.

Detecting Anomalies

Detecting anomalies involves identifying patterns or instances in data that deviate significantly from normal behavior. This can be achieved through various techniques such as statistical methods, machine learning algorithms, or domain-specific rules. Key steps include data preprocessing, feature extraction, model training, and evaluation. Additionally, anomaly detection may involve setting appropriate thresholds, handling imbalanced datasets, and integrating real-time monitoring for timely detection.

Detecting Anomalies



Gather time series data from sensors and monitoring systems.

Analyze historical data to determine normal operating conditions.

Define numeric thresholds for identifying outliers based on baseline statistics.

Flag data points that deviate significantly from baseline behavior.

Analyze anomalous data points to determine root cause and required actions.

Responding to Anomalies

responding to anomalies entails investigating deviations from normal behavior, implementing corrective measures, and updating monitoring systems to prevent recurrence. Effective strategies involve collaboration between analysts, experts, and stakeholders for timely decision-making. Automated response mechanisms and alerts streamline the process, minimizing operational impact

Responding to Anomalies

Review alerts

Analyze the detected anomalies to determine if they are valid issues requiring further investigation

Investigate root causes

Perform root cause analysis to understand the source of the anomaly and if any action is needed to address an underlying problem

Prioritize responses

Rank the anomalies by severity and potential impact to focus efforts on the most critical issues first

Take corrective action

Implement appropriate remediation based on root cause analysis, which may involve tuning detection rules, fixing sensor issues, or addressing a process breakdown

Prevention Methods

Prevention methods involve implementing robust data validation processes, enhancing security measures, and regular system maintenance. Continuous optimization of anomaly detection algorithms and collaboration with domain experts are also essential to mitigate risks effectively.

Prevention Methods

Use Robust Sensors

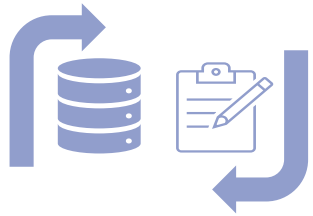
Employ gas sensors with self-diagnostics and fail-safes to detect anomalies.

Regular System Testing

Conduct periodic tests to validate system operation and calibration.

Redundant Monitoring

Have backup monitoring systems to cross-check readings.



Prompt Maintenance

Perform preventive maintenance and calibration per specifications.

Operator Training

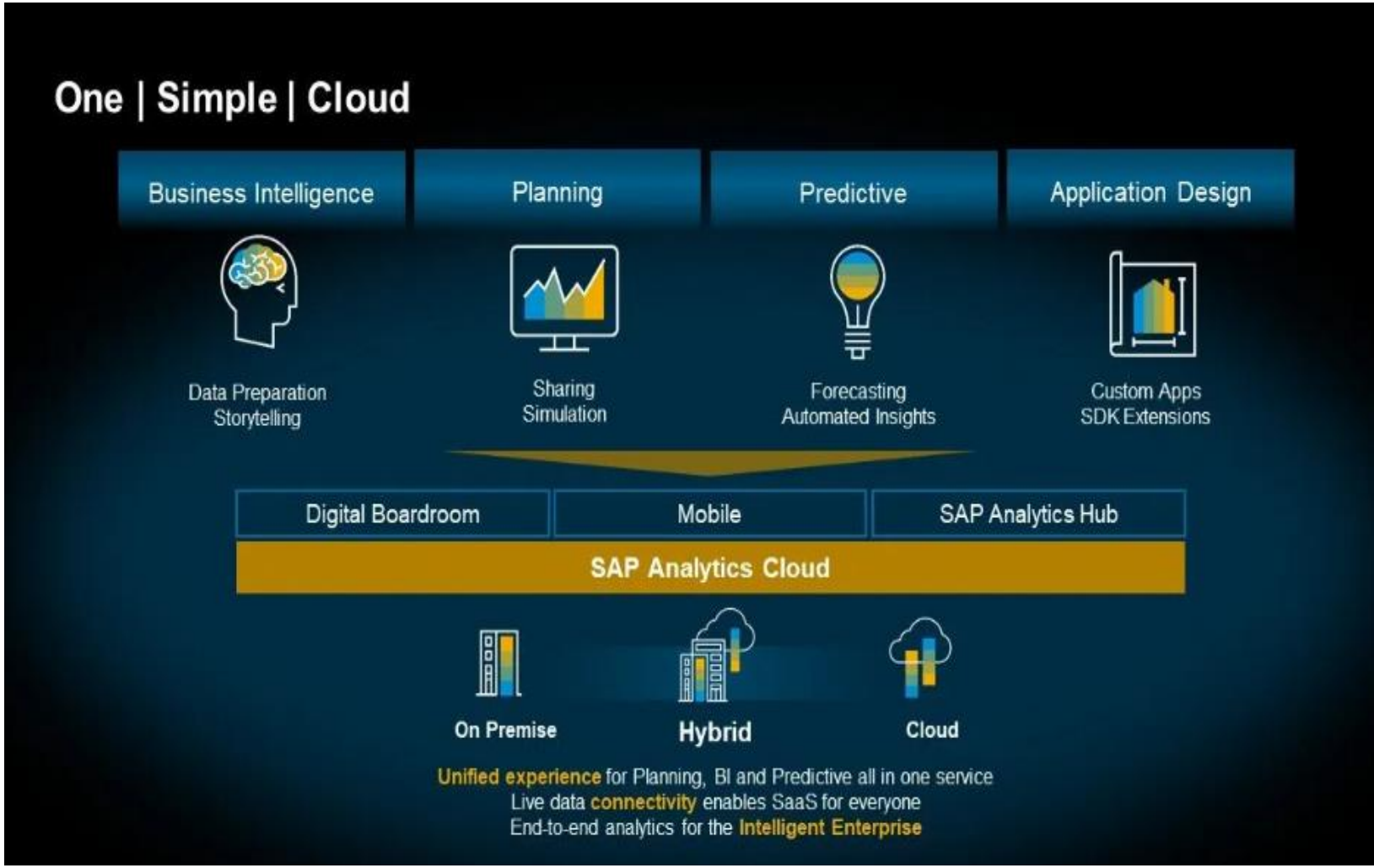
Ensure operators are properly trained to identify anomalies.

System Audits

Perform regular audits to verify compliance with operating procedures.

SAP Solutions for Anomaly Detection

Utilizing SAP Analytics Cloud and SAP Data & Analytics solutions enables real-time monitoring, predictive analytics, and data integration capabilities to identify anomalies in gas utility systems. Leveraging SAP's solutions provides utilities with enhanced visibility across infrastructure, fostering reliability improvements and facilitating proactive maintenance measures



Source: SAP

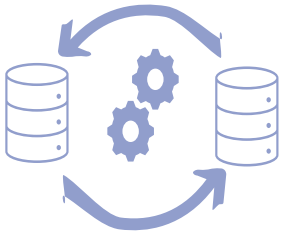
Implementation Strategies

Implementation strategies include integrating anomaly detection systems into existing frameworks, establishing clear response protocols, and providing training. Leveraging scalable technologies and regular evaluation for refinement are also vital for effectiveness.

Implementation Strategies

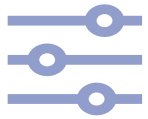
Planning and scoping the implementation

Determine goals, requirements, timelines, resources, and risks for implementing SAP solutions.



Data integration and migration

Extract and integrate data from existing systems and migrate it into SAP Analytics Cloud.



Customization and configuration

Tailor SAP solutions to meet utility-specific needs and configure system settings and rules.

User training and change management

Train employees on using the new

SAP systems and manage the change process..

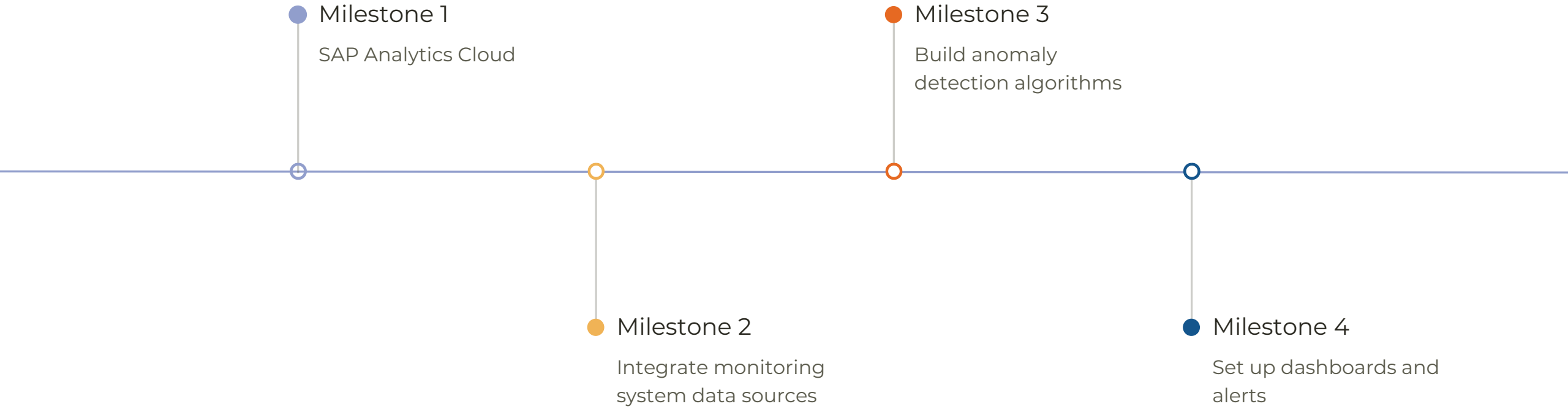
Testing and validation

Perform testing to validate anomaly detection capabilities and ensure proper system integration

Continues improvement

Continuous improvement and embracing new technologies are fundamental for enhancing anomaly detection capabilities in gas utility monitoring systems and operations.

Implementation Strategies



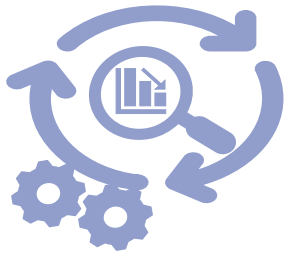
Benefits

Benefits of anomaly detection include improved operational efficiency, enhanced data integrity, reduced downtime, and better risk management. By detecting anomalies early, organizations can mitigate potential damages, minimize financial losses, and maintain customer satisfaction. Additionally, anomaly detection aids in identifying underlying issues and optimizing resource allocation, ultimately leading to cost savings and improved decision-making processes.

Benefits

Reduced operational costs through predictive maintenance

Predictive maintenance minimizes operational costs by proactively addressing equipment issues, reducing downtime, and optimizing resource allocation.



Increased efficiency and productivity

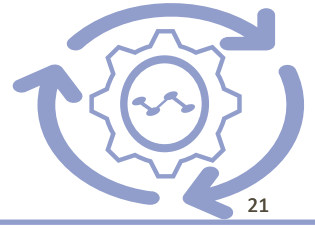
Increased efficiency and productivity streamline operations, maximize output, and optimize resource utilization, leading to enhanced performance and profitability.

Improved reliability and customer satisfaction

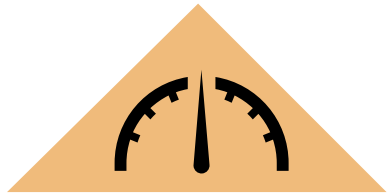
Improved reliability fosters trust, reduces service disruptions, and enhances customer satisfaction by ensuring consistent service quality and reliability

Optimized asset utilization

Optimized asset utilization maximizes resource efficiency, extends asset lifespan, and minimizes unnecessary expenditures, resulting in significant cost savings and improved operational performance.



Data sources



SAP Customer Data

~152,380 — 1 Per Day (Daily Batch)

~325,000 — 1 Per Hr/Day (Hourly Xfer)

~914,285 — 1 Per Hr/Day (Hourly Xfer)

Unlimited — 1 Per Hr/Day (Hourly Xfer)

PERIODIC READS (MONTHLY BILLING)

Our "cash register" data is now more than just for billing or BPEM's. It can be used for understanding developing or realized situations in the field.

OUT-OF-ROUTE (OOR)

This "gold mine" of data that has been collected offers millions of additional data points that are included in calculations.

DATALOGGING READS (INTERVAL READS)

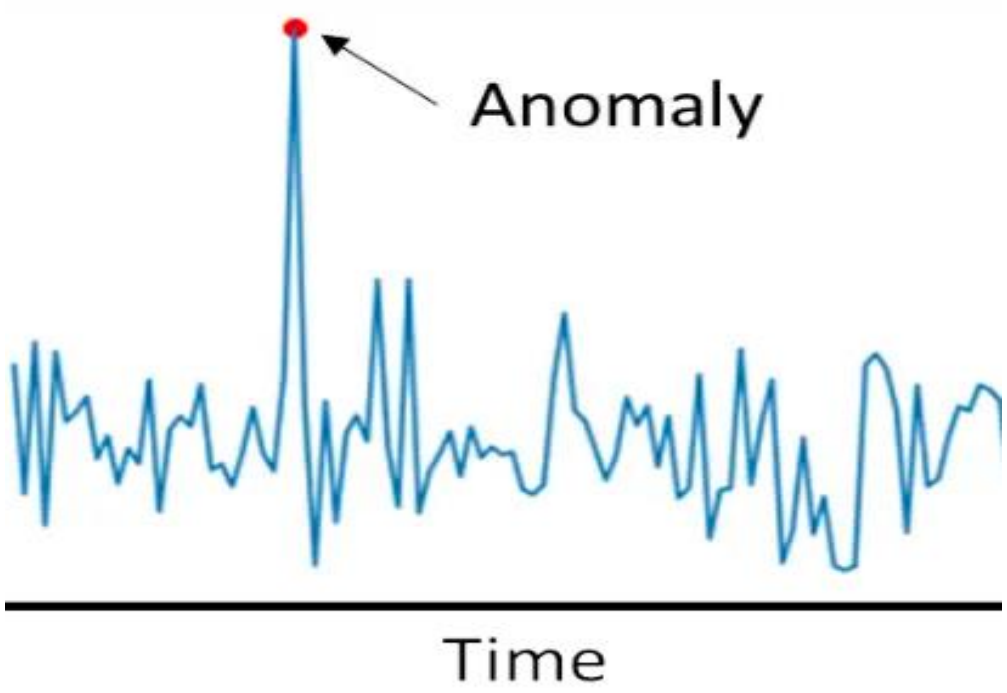
All daily or hourly read intervals (requires premise configuration) are brought into the system within about an hour after receipt by FCS.

ANALYTICS READS (ADDITIONAL COLLECTION)

Specifically targeted routes can be read as needed to gather endpoint data more often than the "normal" 1x per month. This could support proactive evaluation needs or incident updates.

Demonstration

We will now do a live walkthrough demo of detecting anomalies in sample utility monitoring data using the new capabilities in SAP Analytics Cloud. This will showcase how easy it is to start uncovering insights into your utility operations.



Scenarios

- Valve Closed w/ High Temp
- Valve Closed w/ High Flow
- Valve Closed w/ High Pressure
- Low Battery
- Tampering
- Air-in-Pipe w/ Potential Tampering
- Meter Error Condition
- No Situation / "Normal" w/ Air-in-Pipe
- Broken ERT
- Damage After Meter
- Damage Before Meter
- Meter Damage w/ No Indicators
- Dead Battery

Valve Closed w/ High Temperature

Story

On the night of 2/23/2023, a house fire occurred at the neighbor's residence. Since the neighbors didn't have natural gas service, SWG wasn't contacted. This event impacted the currently unoccupied Premise, with no existing customer complaints. Data doesn't suggest any breaches, but gas flow ceased at the meter due to a High Temp trigger.

Details:

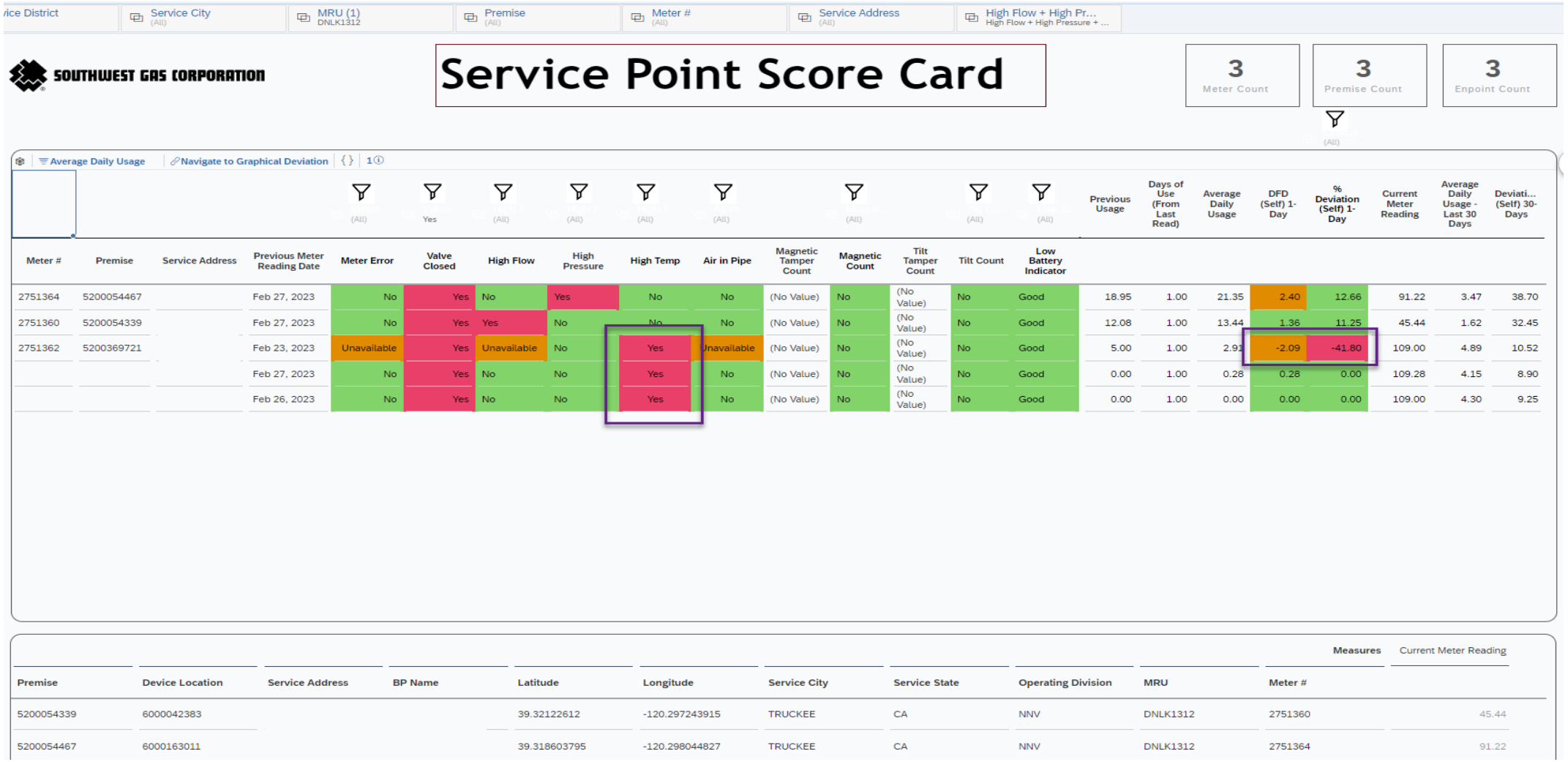
Intelis Valve Closed and High Temp flags exist:

1. DFD may/may not display deviation, at least 1 deviation is likely after valve closure occurs
2. No Tamper # change
3. HighTemperature = Yes
4. ValveClosed = Yes
5. Graphical Deviations show trend and approx. shutoff timeframe 2/23-2/24. 2/25 shows zero 1-Day DFD or deviation which means issue likely occurred 2 days prior (2/23), however, it is possible midnight one day prior (2/24) is involved.
6. Interval Data reinforces normal consumption trend and then DFD stops to further reinforce fact that valve has been closed and gives some insight to approx. closure timing.
7. Truck roll with SO for Investigation, likely replace meter due to temperature situation

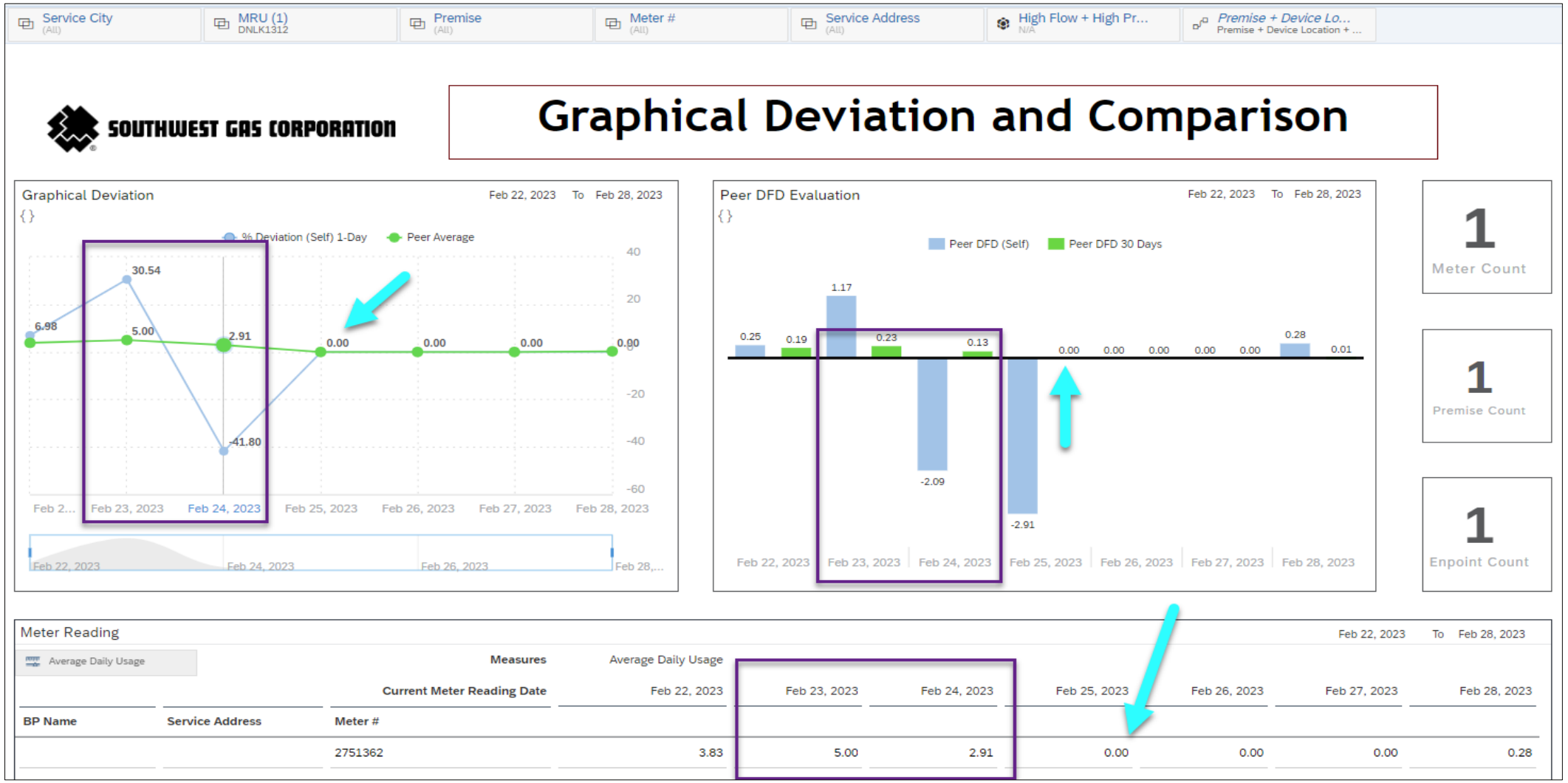
Example:

1. Premise No. - 5200369721
2. Endpoint No. - 110056908

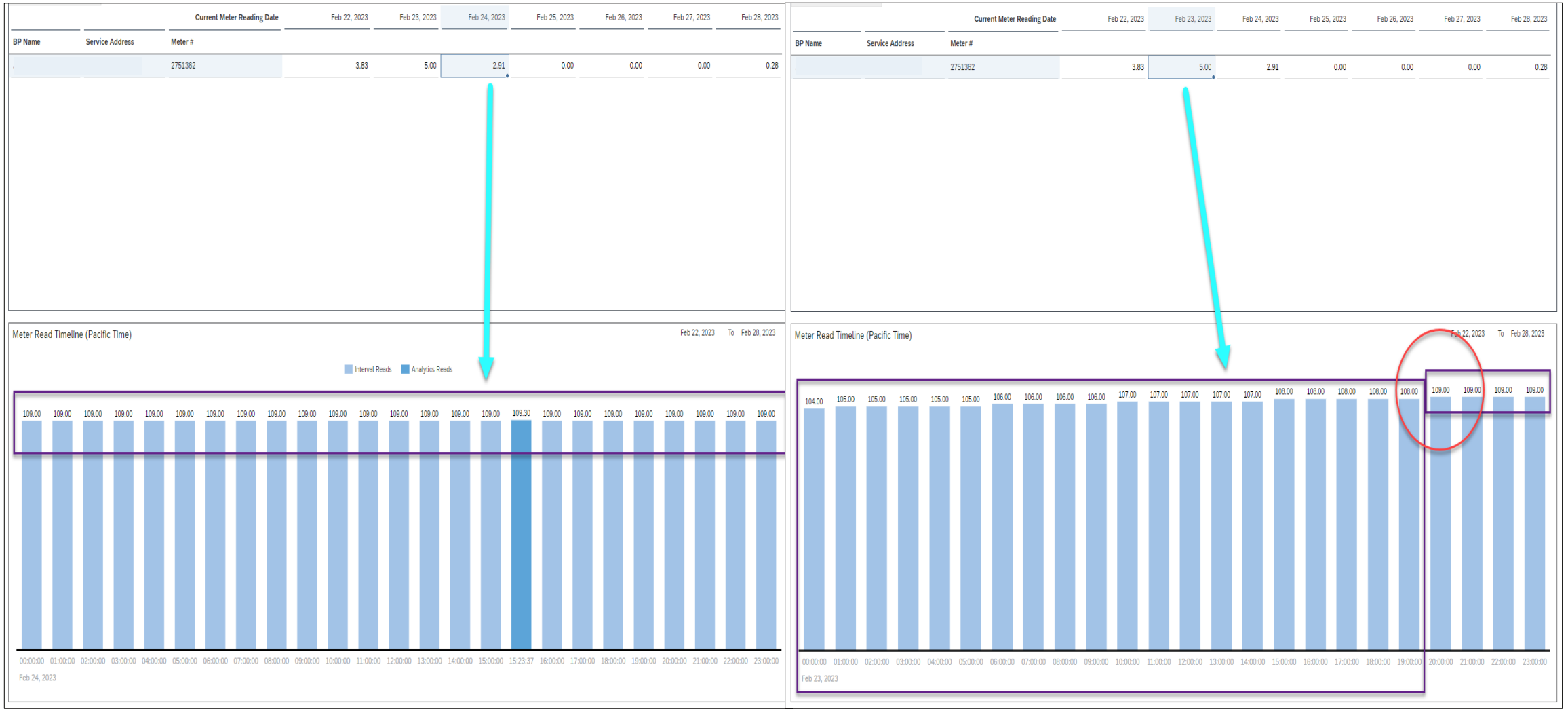
Valve Closed w/ High Temperature



Valve Closed w/ High Temperature



Valve Closed w/ High Temperature



Low Battery

Story:

To maintain proactive assessment of my fielded endpoints (ERTs and Intelis Meters), I aim to replace any failing batteries before complete failure. By monitoring 100G, 500G, and Intelis endpoints, I can detect if they are deteriorating. When an endpoint initially reports a "bad" status, it typically has approximately 2 years of remaining battery life. If this is the sole indicator for an endpoint, no Emergency Service Order (SO) is required.

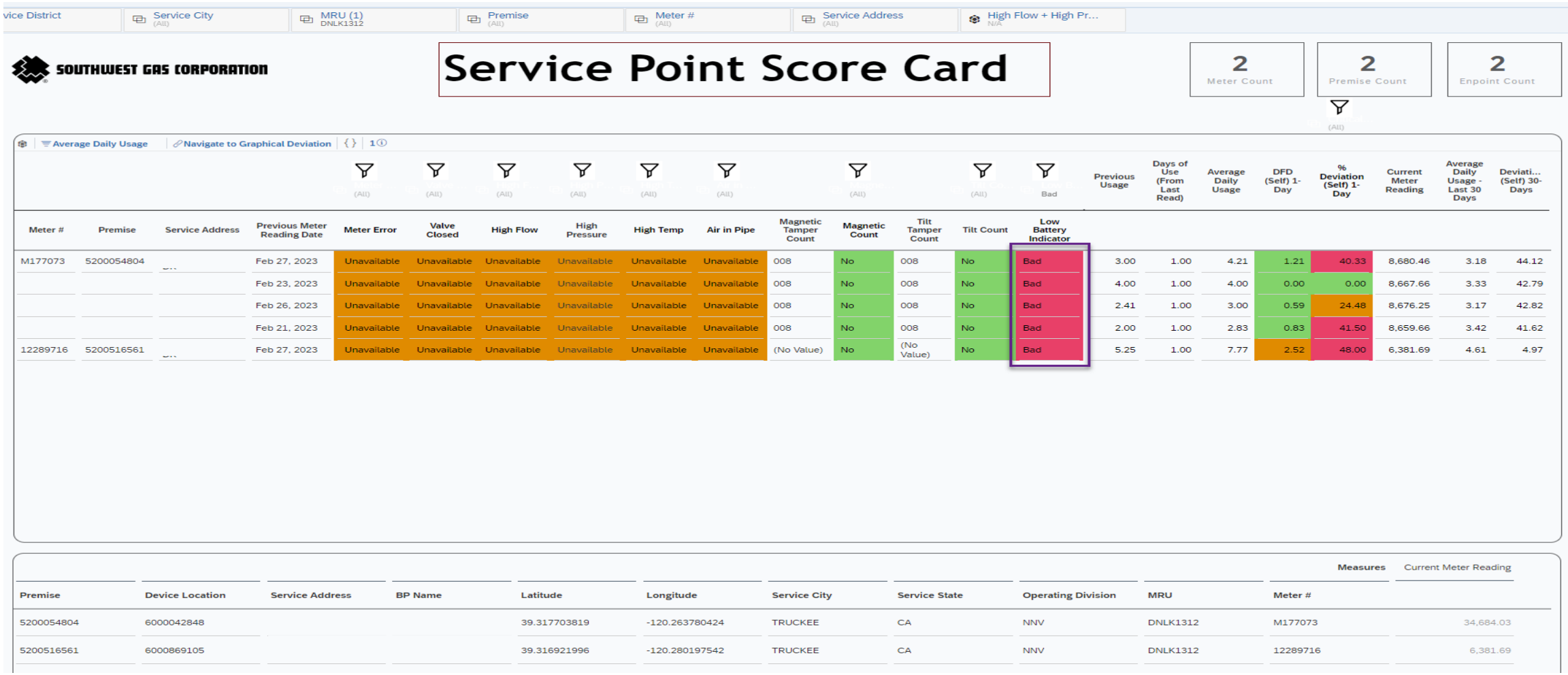
Details:

1. Deviation or another indicator may/may not exist
2. LowBattery = Yes
3. Create Maintenance SO

Example:

1. Premise No. - 5200054804
2. Endpoint No. - 99323839

Low Battery



Meter #	Premise	Service Address	Previous Meter Reading Date	Meter Error	Valve Closed	High Flow	High Pressure	High Temp	Air in Pipe	Magnetic Tamper Count	Magnetic Count	Tilt Tamper Count	Tilt Count	Low Battery Indicator	Previous Usage	Days of Use (From Last Read)	Average Daily Usage	DFD (Self) 1-Day	% Deviation (Self) 1-Day	Current Meter Reading	Average Daily Usage - Last 30 Days	Deviati... (Self) 30-Days
M177073	5200054804		Feb 27, 2023	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	008	No	008	No	Bad	3.00	1.00	4.21	1.21	40.33	8,680.46	3.18	44.12
			Feb 23, 2023	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	008	No	008	No	Bad	4.00	1.00	4.00	0.00	0.00	8,667.66	3.33	42.79
			Feb 26, 2023	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	008	No	008	No	Bad	2.41	1.00	3.00	0.59	24.48	8,676.25	3.17	42.82
			Feb 21, 2023	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	008	No	008	No	Bad	2.00	1.00	2.83	0.83	41.50	8,659.66	3.42	41.62
12289716	5200516561		Feb 27, 2023	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable	(No Value)	No	(No Value)	No	Bad	5.25	1.00	7.77	2.52	48.00	6,381.69	4.61	4.97

Premise	Device Location	Service Address	BP Name	Latitude	Longitude	Service City	Service State	Operating Division	MRU	Meter #	Measures: Current Meter Reading
5200054804	6000042848			39.317703819	-120.263780424	TRUCKEE	CA	NNV	DNLK1312	M177073	34,684.03
5200516561	6000869105			39.316921996	-120.280197542	TRUCKEE	CA	NNV	DNLK1312	12289716	6,381.69

Air-in-Pipe w/ Potential Tampering

Story:

Over the weekend, a customer attempted to tamper with their gas, assuming SWGas wouldn't be monitoring their meter. Despite restoring the meter before our Monday reading, tampering indicators and Interval Reads provide insight, allowing us to assess the situation before dispatching a truck for investigation.

Details:

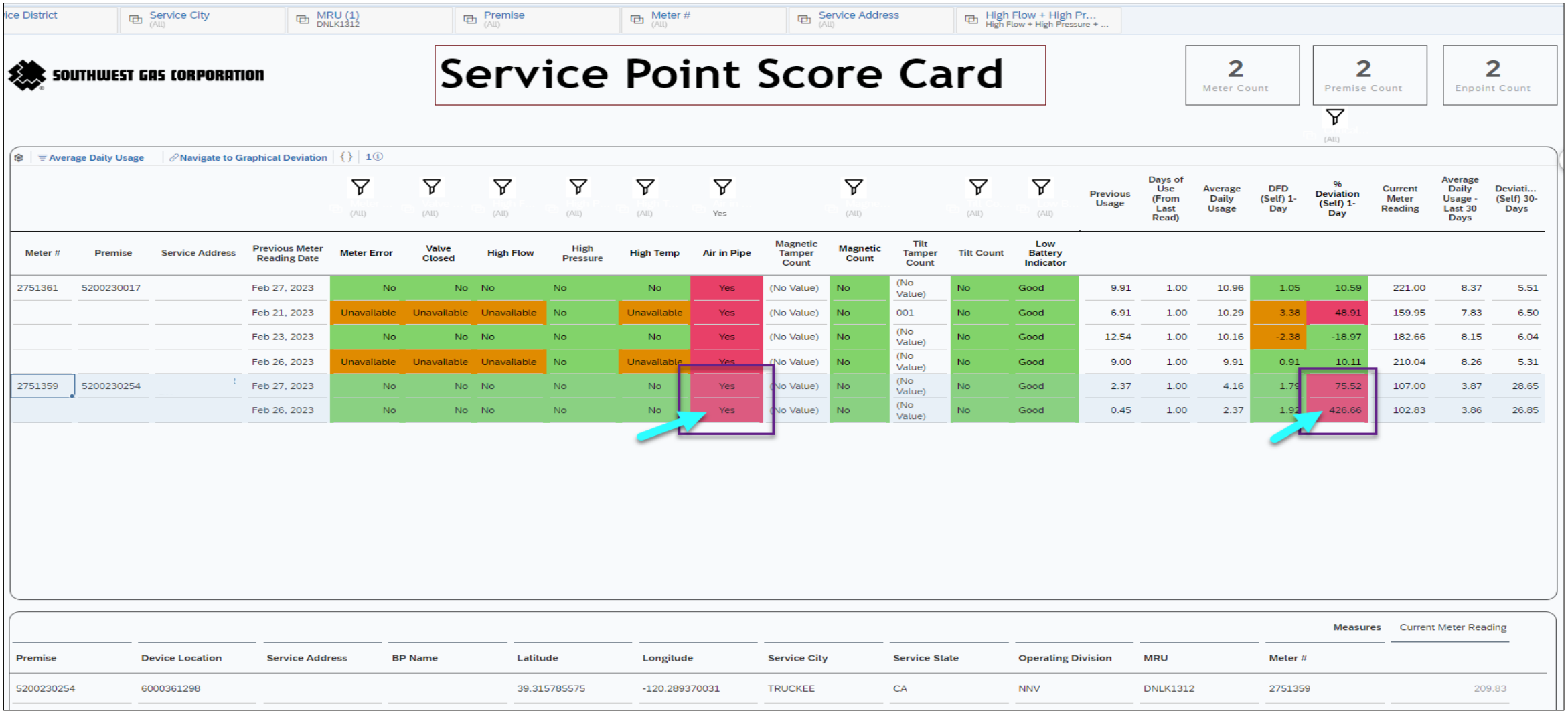
This Air-in-Pipe condition displays for 40 days after the trigger occurs and does not go away until then. It can exist for all new installations and service work for an Intelis that interrupts flow OR if tampering/damage occurs:

1. AirInPipe = Yes begins on 2/27
2. Research of Premise indicates no SO's exist for premise in last 40 days = likely tampering
3. Deviation % is very high on 2/27 and has surrounding days with unusual deviations, especially considering the recent weather patterns over the weekend
4. Graphs indicate a drop in DFD 2/25 to 2/26 and then large spike on 2/27, doesn't align with peers
5. Interval Reads show gaps in DFD (can display in numerous ways). Notice that prior to the anomaly that starts on 2/24 there are DFD's displayed every couple hours.
6. Truck roll for with SO for investigation, likely tampering.

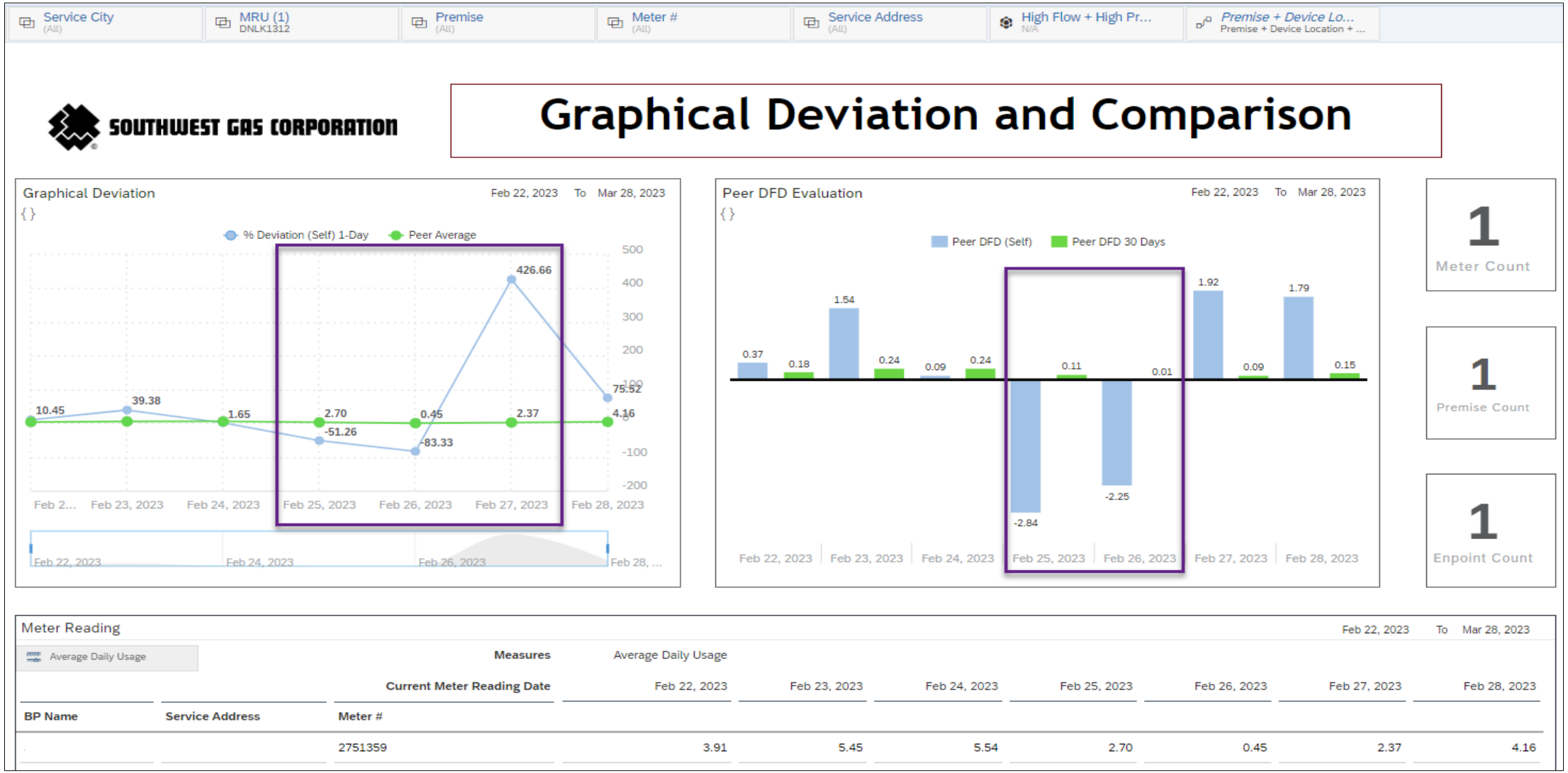
Example:

1. Premise No. - 5200230254
2. Endpoint No. – 110060274

Air-in-Pipe w/ Potential Tampering

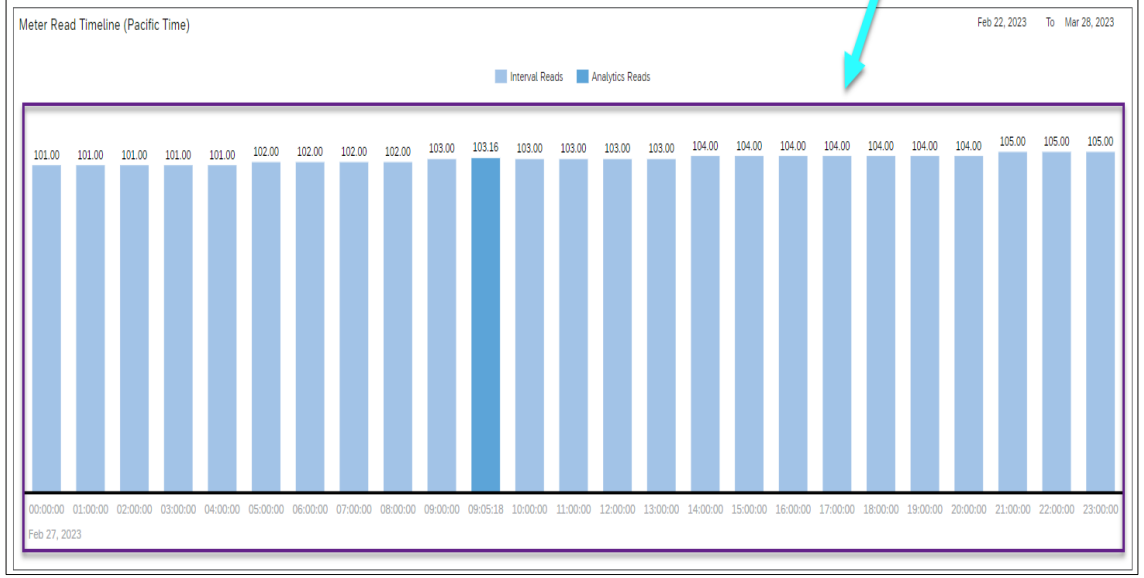


Air-in-Pipe w/ Potential Tampering



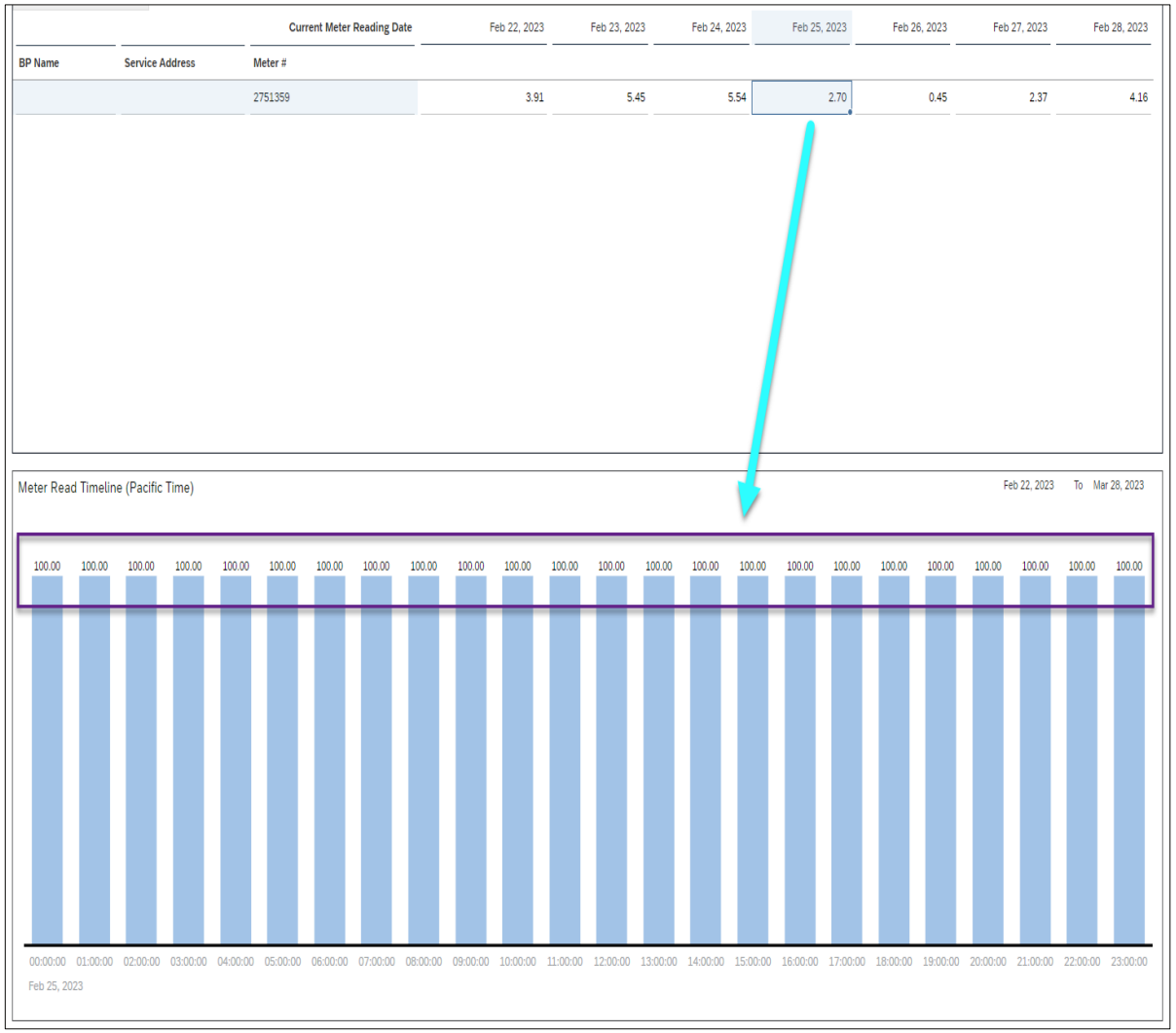
Air-in-Pipe w/ Potential Tampering

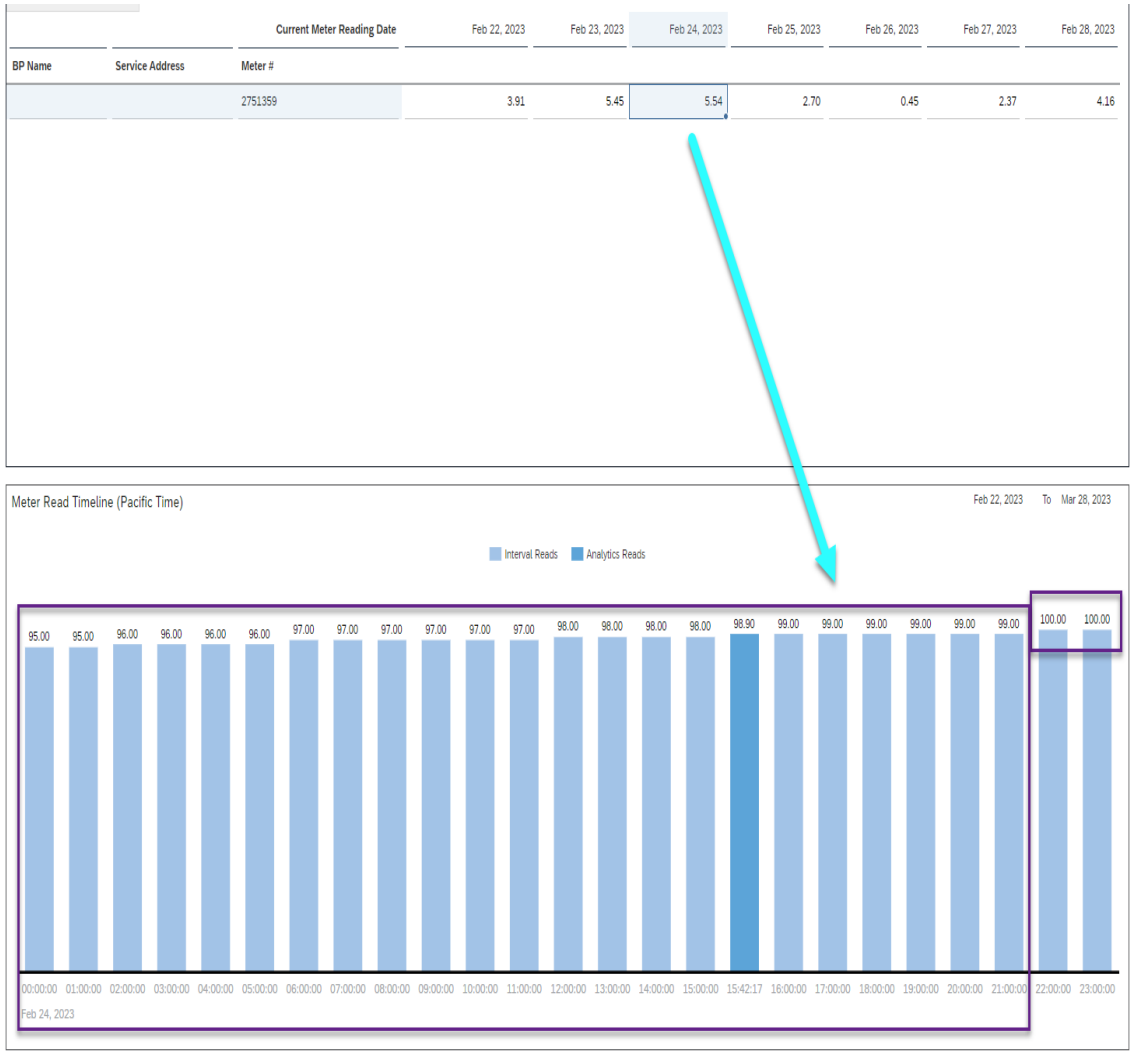
BP Name	Service Address	Meter #	Current Meter Reading Date	Feb 22, 2023	Feb 23, 2023	Feb 24, 2023	Feb 25, 2023	Feb 26, 2023	Feb 27, 2023	Feb 28, 2023
		2751359		3.91	5.45	5.54	2.70	0.45	2.37	4.16



BP Name	Service Address	Meter #	Current Meter Reading Date	Feb 22, 2023	Feb 23, 2023	Feb 24, 2023	Feb 25, 2023	Feb 26, 2023	Feb 27, 2023	Feb 28, 2023
		2751359		3.91	5.45	5.54	2.70	0.45	2.37	4.16

Air-in-Pipe w/ Potential Tampering





Meter Error Condition

Story:

During a team member's absence on 2/27, another team member forgot to check for any Meter Error conditions. Today, 2/28, upon the return of the team member, it was discovered that a Meter Error had been present since at least yesterday.

Details:

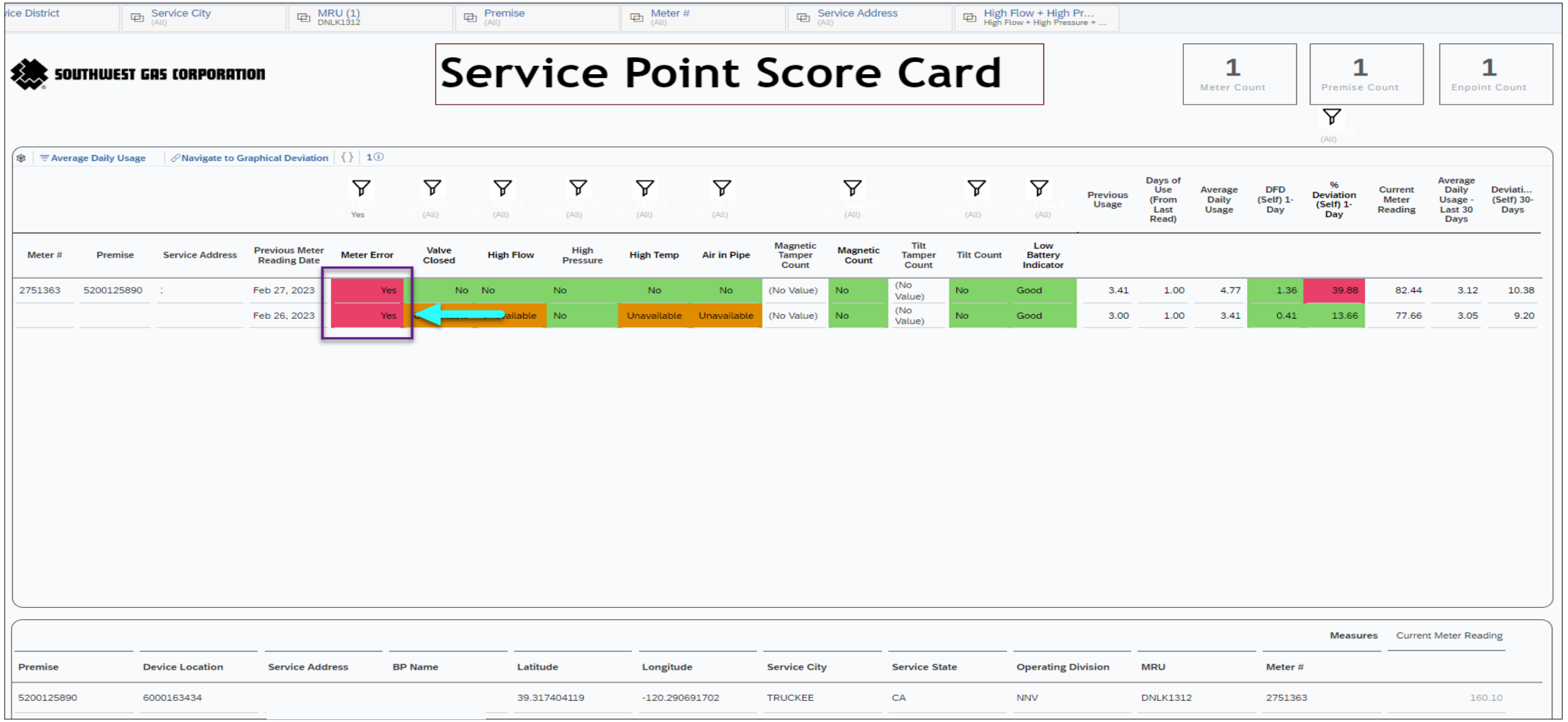
DFD can display normal or show deviations depending on the kind of error that exists and has been recognized by the meter. No matter the reason, an error condition reported by an Intelis meter means there is impact to ERT/UMU (measurement unit), irrevocable tampering, mechanics, etc. and it needs replacement to be reliable:

1. DFD may/may not display deviation
2. MeterError = Yes
3. Any other condition or data captured with a "meter error" should be considered irrelevant/unreliable
4. Truck Roll with SO to replace meter required

Example:

1. Premise No. - 5200125890
2. Endpoint No. - 110059010

Meter Error Condition



No Situation / “Normal” w/ Air-in-Pipe

Scenario:

No Situation / "Normal" w/ Air-in-Pipe

Details:

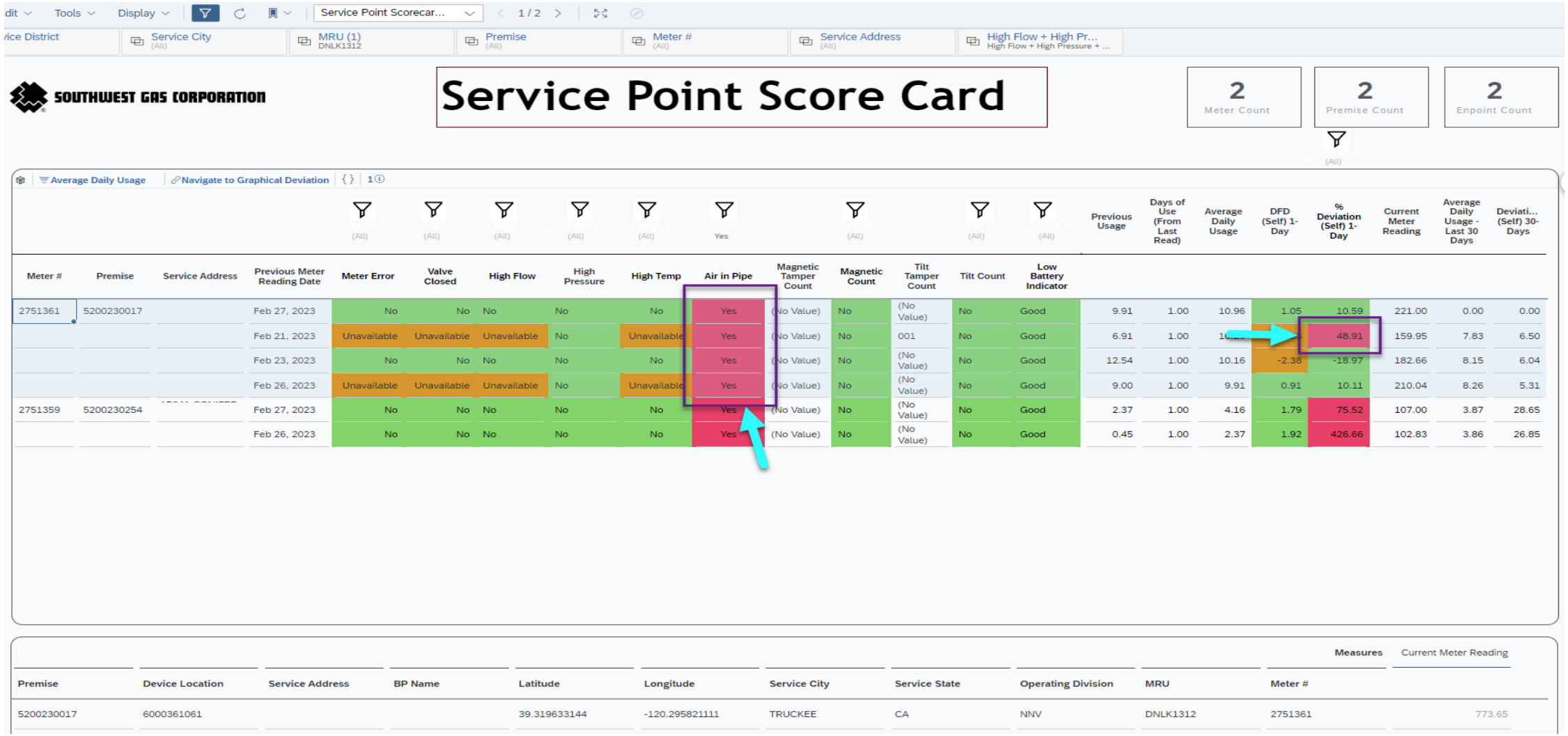
This condition displays for 40 days after the trigger occurs and does not go away until then. It will likely exist for all new installations and service work for an Intelis:

1. DFD may/may not display deviation (no impact on this focused triggering event)
2. AirInPipe = Yes
3. Research of Premise indicates installation of Intelis within the last 40 days
4. No Tamper or other data indicates an issue, including Interval Reads
5. Research from graphs and interval data reveal no concerns, likely deviations exist due to weather impacts on use
6. No truck roll or SO required

Example:

1. Premise No. - 5200230017
2. Endpoint No. - 110059154

No Situation / “Normal” w/ Air-in-Pipe



Meter #	Premise	Service Address	Previous Meter Reading Date	Meter Error	Valve Closed	High Flow	High Pressure	High Temp	Air in Pipe	Magnetic Tamper Count	Magnetic Count	Tilt Tamper Count	Tilt Count	Low Battery Indicator	Previous Usage	Days of Use (From Last Read)	Average Daily Usage	DFD (Self) 1-Day	% Deviation (Self) 1-Day	Current Meter Reading	Average Daily Usage - Last 30 Days	Deviati... (Self) 30-Days
				(All)	(All)	(All)	(All)	(All)	Yes		(All)		(All)	(All)									
2751361	5200230017		Feb 27, 2023	No	No	No	No	No	Yes	(No Value)	No	(No Value)	No	Good	9.91	1.00	10.96	1.05	10.59	221.00	0.00	0.00
			Feb 21, 2023	Unavailable	Unavailable	Unavailable	No	Unavailable	Yes	(No Value)	No	001	No	Good	6.91	1.00	1		48.91	159.95	7.83	6.50
			Feb 23, 2023	No	No	No	No	No	Yes	(No Value)	No	(No Value)	No	Good	12.54	1.00	10.16	-2.38	-18.97	182.66	8.15	6.04
			Feb 26, 2023	Unavailable	Unavailable	Unavailable	No	Unavailable	Yes	(No Value)	No	(No Value)	No	Good	9.00	1.00	9.91	0.91	10.11	210.04	8.26	5.31
2751359	5200230254		Feb 27, 2023	No	No	No	No	No	Yes	(No Value)	No	(No Value)	No	Good	2.37	1.00	4.16	1.79	75.52	107.00	3.87	28.65
			Feb 26, 2023	No	No	No	No	No	Yes	(No Value)	No	(No Value)	No	Good	0.45	1.00	2.37	1.92	426.66	102.83	3.86	26.85

Measures: Current Meter Reading

Premise	Device Location	Service Address	BP Name	Latitude	Longitude	Service City	Service State	Operating Division	MRU	Meter #	
5200230017	6000361061			39.319633144	-120.295821111	TRUCKEE	CA	NNV	DNLK1312	2751361	773.65

Wrap Up

Where to Find More Information

- Data and Analytics - SAP
- Utilities - SAP
- Data Analytics for Advanced Metering Infrastructure - Energy and Extractives Global Practice Group South Asia Region (SAR)
- Sap Insider Whitepapers - SAP
- Data Visualization: A Handbook for Data Driven Design - Andy Kirk
- The Big Book of Dashboards: Visualizing Your Data - Steve Wexler, Jeffrey Shaffer, Andy Cotgreave
- Gas Utility Monitoring Systems Market Size Data Analysis Handbook - Mr. Glen
- Anomaly Detection of Consumption - Tomás Mendes,Pedro J. S. Cardoso ,Jânio Monteiro , and João Raposo

Key Points to Take Home

- Enhanced Visibility: Leveraging SAP Analytics Cloud provides with deeper insights into utility monitoring, uncovering unnoticed anomalies.
- Proactive Maintenance: Leveraging SAP Data analytics solutions enables customers to preempt issues, reducing downtime with preventive measures.
- Improved Decision-Making: Insights from SAP Analytics Cloud inform Southwest Gas's asset management and resource allocation, enhancing overall performance.
- Streamlined Operations: Real-time anomaly identification minimizes disruptions, optimizing system performance.
- Increased Reliability: Proactive anomaly resolution boosts the reliability of utility monitoring, ensuring consistent service delivery.

Thank you! Any Questions?

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Please remember to complete your session evaluation.

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