



KUWAIT 3RD FLOW MEASUREMENT TECHNOLOGY CONFERENCE

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إحدى شركات مؤسسة البترول الكويتية
A Subsidiary of Kuwait Petroleum Corporation



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**Recent Trends in Field Verification of
Flow meters**

Maintain the performance of the Metering system

- Perfect system, optimal design – what next? A Custody transfer measurement system will only be as good as the process used to maintain and manage the ongoing performance
- Once you start running a real fluid through a new measurement system it's performance will only degrade over time unless steps are taken to maintain the measurement traceability

Day 1 is the best performance you can expect from any Custody Transfer measurement system

“Erroneous measurement or incorrect allocation procedure presents significant technical and financial risk to all the stake holders.”

PetroMin Pipeliner, April-June 2012

Custody Transfer Systems Issues Can Be Addressed by Focusing on Three Critical Areas

Challenge



Reliability



Accuracy



Conformance

Unexpected downtime affects the top and bottom line

Increased system uncertainty may increase unaccounted for losses

Non-conformance may lead to disputes, fines and / or legal action

Solution

Shift to a more predictive maintenance approach

Eliminate reactive or time-based maintenance approaches

Robust analytics enable detection of parameter drift before it affects measurement uncertainty

Consolidate key documentation and reports in one secure location to streamline the audit process

Intelligent Metering Systems GOAL: Ensure Maximum Profitability



Reduce or even eliminate **unplanned downtime** through remote monitoring of key health parameters with algorithms that cross-verify instrument and meter health

- Shift from reactive to predictive work orders
- Reduce the number of site visits



Minimize **system uncertainty and improve Measurement Confidence**



Verify measurements and simplify document preparation for **performance audits**

- Produce and store important documents in one comprehensive database

Diagnostic/verification function

The goal of any diagnostics system is provide information that the user can use to make a decision or perform a function, these can be grouped within the following main areas

Functional Diagnostics

- Is the meter working within specification parameters

Process Diagnostics

- Is the meter giving me information about the current conditions

Cross Integrity Diagnostics

- Can I use this and other diagnostic data to check overall function

Actionable Insights



Diagnostics can provide confidence in the meter, installation and operational process

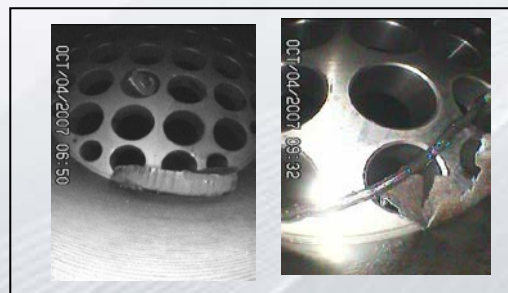
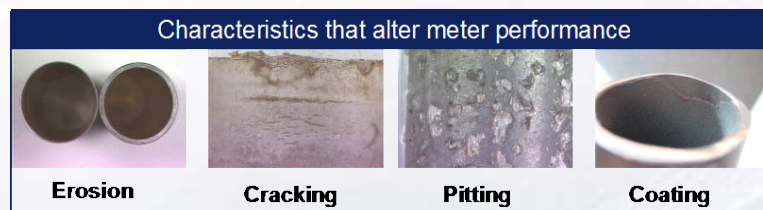
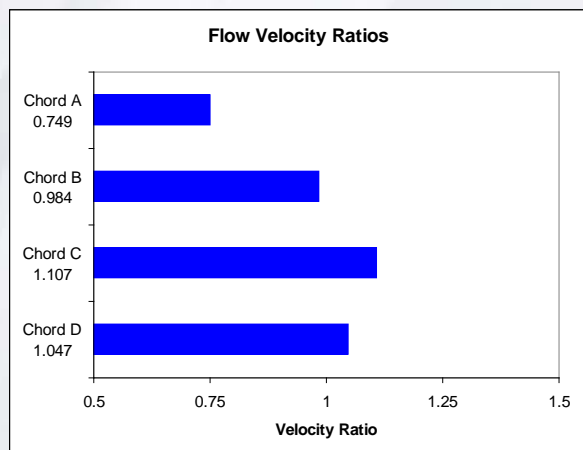
Measurement Integrity – Benefits of field meter verification

- Confidence in flow meter performance and measurement integrity
- Predicting Reliability of Flow Meter
- Confirming the Physical Integrity of the meter
- Reduce preventive maintenance and calibration requirements
- Process trouble shooting



Actionable Alerts

- Alerts are generated by deviations from an initial baseline value
- Baselines can be established at the calibration lab or upon initial start-up.
- Baselines established at the calibration lab and verified upon start up can identify installation effects that add to uncertainty of measurement

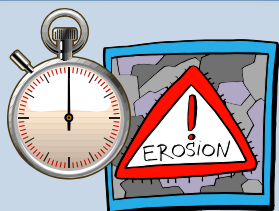


Meter Verification Use Models



Troubleshooting Aid

- Rapid Feedback and Gratification
- Exclude Meter to Focus Elsewhere



Condition Monitoring

- Regular Scheduled Testing
- Trending
- Expectation of Damage



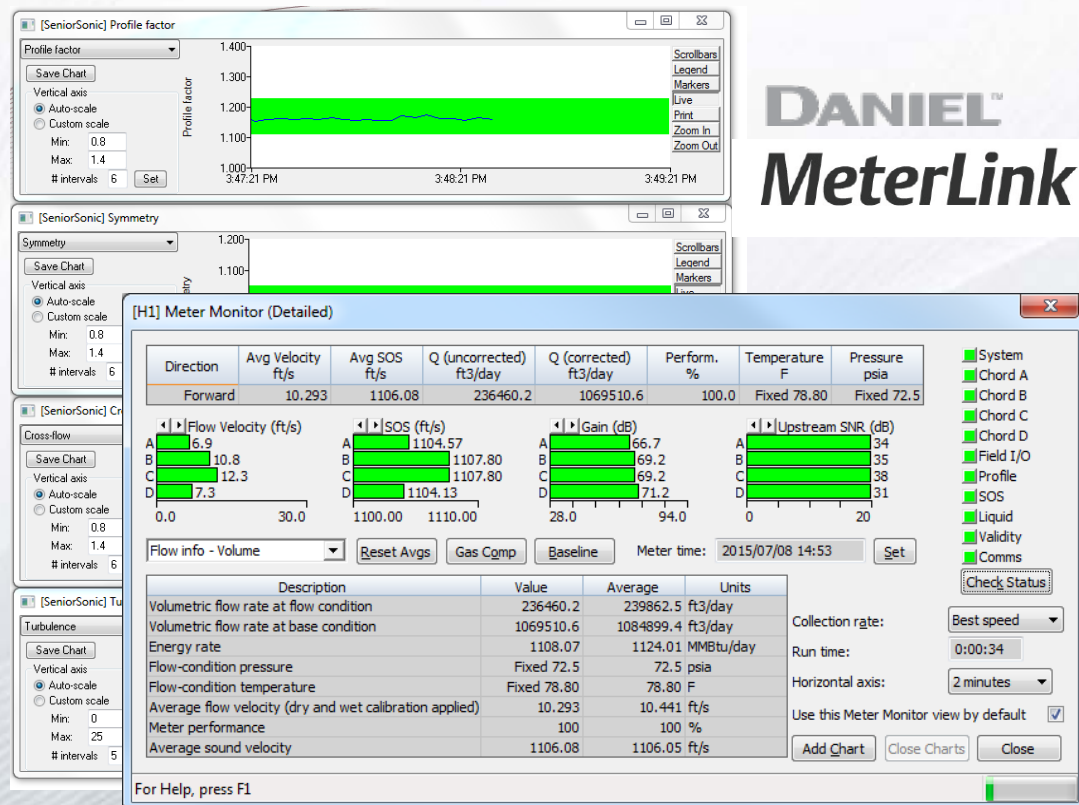
Measurement Verification

- Detailed Certificate
- Verification Following Transfer
- Assurance of Stability

Diagnostics for simple system checks and performance monitoring - USM

- Dynamic Flow-Based Diagnostics
 - Profile factor
 - Symmetry
 - Cross flow
 - Swirl
 - Turbulence
- Performance-Based Meter Diagnostics
 - Signal-to-noise ratio
 - Upstream and downstream gain
 - Average Speed of Sound
 - Individual path speed of sound
 - Path Performance

Minimize and monitor measurement uncertainty with real-time detection of changing flow dynamics



Dual-Configuration Gas Ultrasonic Meters

Combination of **two meters in one** meter body for improved measurement confidence, verification, process insight and accuracy

Primary Meter

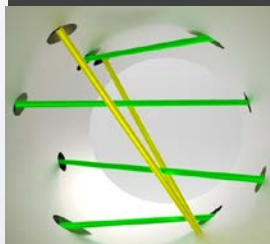
All Models - 4-path Daniel
British Gas Fiscal Meter



Secondary Meter

3415 - Single-Path Check
3416 - Single-Path Check w/ Bottom Diagnostic
3417 - 4-path Daniel British Gas Fiscal Meter

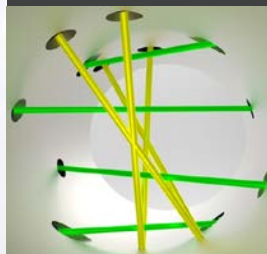
3415 (4+1)



Verification

- Measurement verification with an integral check meter
- Provides early warning of process issues

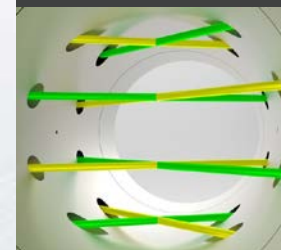
3416 (4+2)



Verification/Detection

- Measurement verification with an integral check meter
- Diagnostic path helps determine the cause of a shift
- Detects pipe bottom contamination

3417 (4+4)



Reliability/Value

- Premium reliability with fully redundant design
- Two independent fiscal/custody meters in one meter body

Ultrasonic Insight (Condition Based Monitoring)

Functionality:

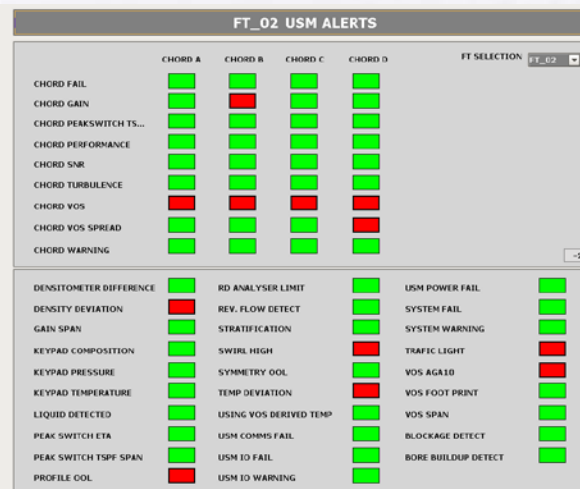
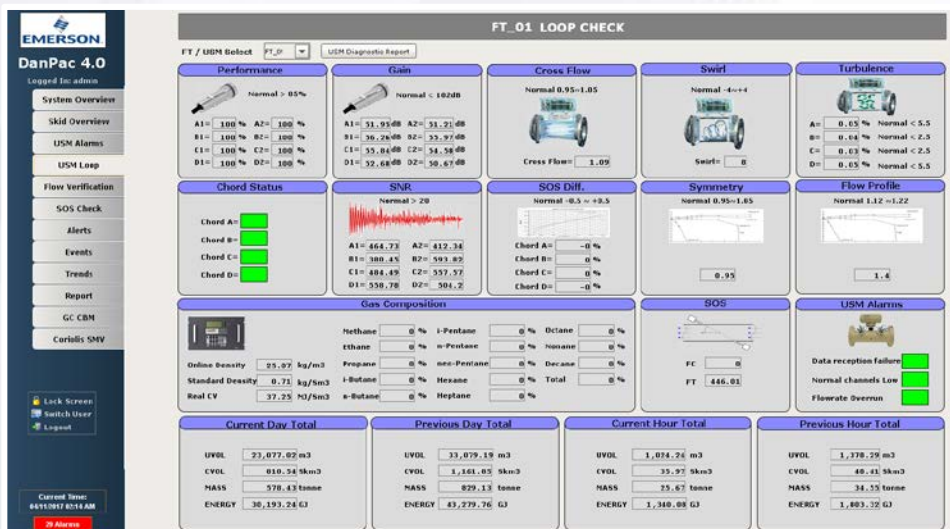
Remotely track and trend key ultrasonic meter parameters to ensure that customers are notified of any drift that would affect metering accuracy

Application Value:

Provide contextual insights and suggest actions when alarms are triggered. We don't want to just generate and show more data

Customer Benefits:

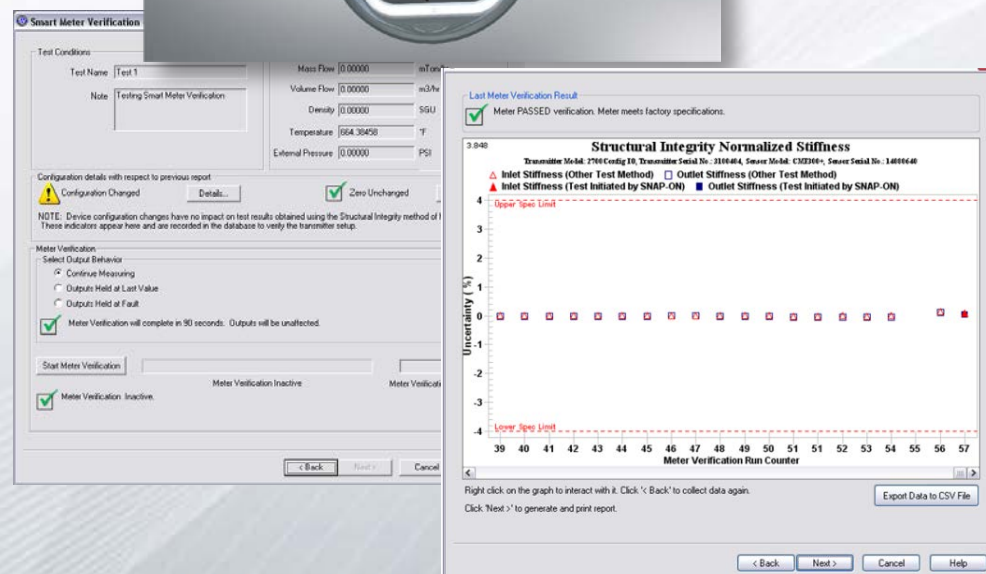
When a parameter starts drifting, Ultrasonic CBM will alert the customer before a failure occurs, allowing the customer to schedule repairs during their next maintenance break



Diagnostics for simple system checks and performance monitoring - Coriolis

- Dynamic Flow-Based Diagnostics
 - Meter Zero Verification
 - Density
 - Tube Temperature
 - Erosion, corrosion, tube damage
- Performance-Based Meter Diagnostics
 - Meter Zero Verification
 - Drive gain levels
 - Left Right Pickoff
 - Tube Stiffness

Minimize and monitor measurement uncertainty with real-time detection of changing flow dynamics



Coriolis Insight (Smart Meter Verification)

Functionality:

Remotely trigger or schedule verification that Coriolis meter parameters are within acceptable calibration ranges

Application Value:

Provide contextual insights and suggest actions when alarms are triggered. We don't want to just generate and show more data

Customer Benefits:

When a parameter starts drifting, Coriolis Insight will alert the customer before a failure occurs, allowing the customer to schedule repairs during their next maintenance break

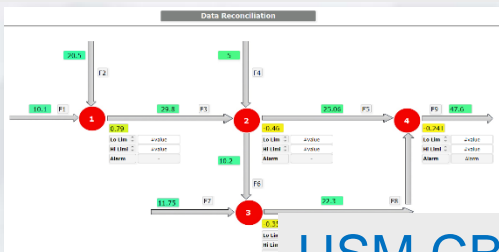
Connecting devices to a Intelligent Metering Supervisory System

- Individual instruments and meters connected to an Intelligent monitoring supervisory for onsite or remote monitoring and performance checks

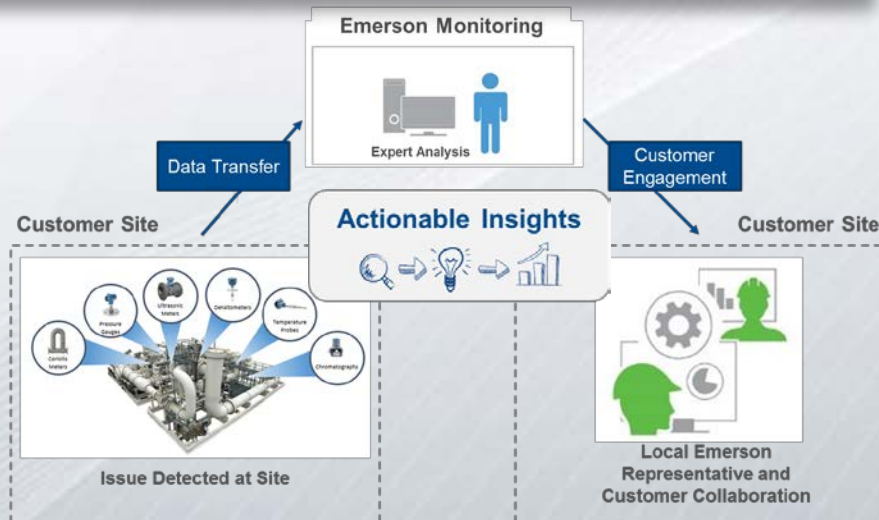
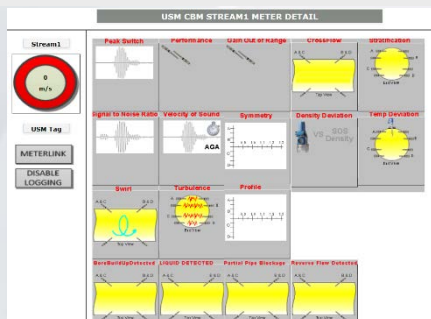
Maintenance Dashboard



Data Reconciliation



USM CBM Coriolis SMV



Metering Validation and Verification

- Verify Electronic Flow Measurement
- Both online and offline verification
- Report generation can be scheduled or triggered when needed
- CalPac uses industry standard equations

Liquid		Gas	
ASTM D1250 / IP 200 Tables – 1952, 1980, 2004/07	١	GPA 2172 – 1996, 2009	١
API MPMS 11.1 – 1980, 2004/07	٢	ISO 6976 – 1983, 1995 and AGA 5 – 2009	٢
API 11.2.1 – 1984	٣	GPA 2145 – 2000, 2009	٣
API 11.2.2 – 1986	٤	AGA 8 1985 & 1994, NX-19, RedLich –Kwong	٤
API 11.2.4 – 1998, 2004/07 (TP 25)	٥	AGA 3 1985, AGA 3 / API 14.3.3 1992, 2013	٥
API 11.2.5 – 2007 (GPA TP – 15)	٦	ISO 5167 1991, 1998 & 2003	٦
Meter K Factor Calculations – Prover method.	٧	AGA 7 – 2006	٧
Local Gravity and Pressure Calculations	٨	AGA 10 – 2003	٨
		ISA 1932	٩

Previous Next Report trigger

Calculation Mode Online Calculate

Flowing Conditions	
Differential Pressure	10 kPa
Gauge Pressure	4000 kPa
Flowing Temperature	10 °C
Atmospheric Pressure	101.325 kPa
Flow Duration	0 days

Orifice Plate	
Bore Diameter	50.8 mm
Ref. Temperature	20 °C
Plate Material	2

Base Conditions	
Base Pressure	101.325 bar
Base Temperature	15.5556 °C

Meter Tube	
Internal Diameter	0 mm
Ref. Temperature	0 °C
Pipe Material	2
Gauge Pressure Tap Location	Upstream

Results	
Volume Flow Rate at Pb, Tb	0 E3M3/day
Volume Flow Rate at Pf, Tf	0 m³/hr
Mass Flow Rate	NaN kg/sec
Energy Flow Rate	0 GJ/d
Corrected Gas Volume	0 m³
Velocity Of Sound	0 m/sec

Calculation Method	
AGA Report #3, 1990	

Prev 1 2 3 Next

CalPac-Gas Calculations

Detail Report

Setup Info	
Meter Type	Orifice
Product Type	Natural Gas
Flow Durations	1 days
Calculations	GPA 2172
	GPA 2172 AGA-8 1994, Detail

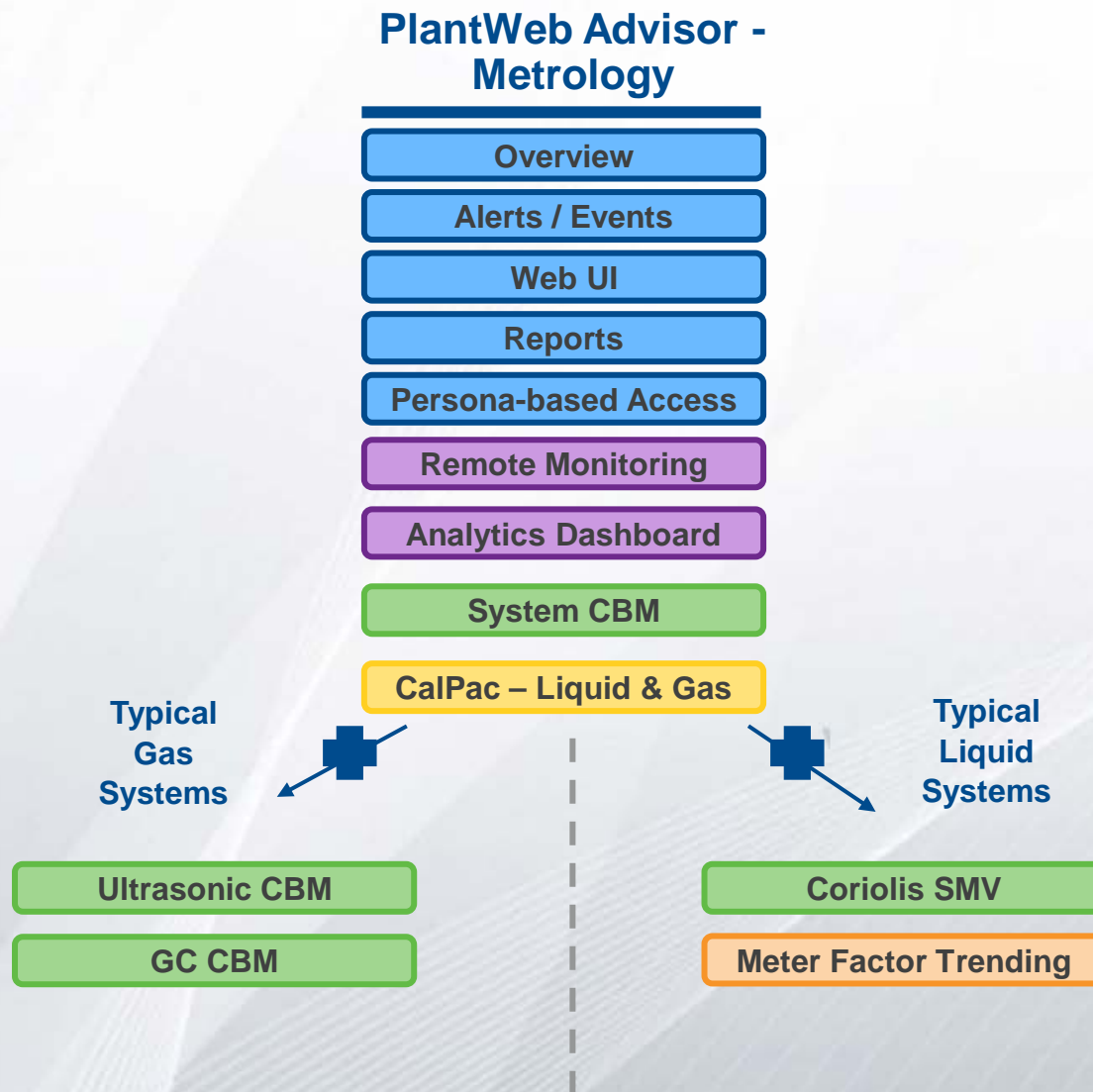
Pressure & Temperature Conditions	
Gauge Pressure	4000.0000 kPa
Atmospheric Pressure	101.3250 kPa
Absolute Pressure	101.3250 kPa
Base Pressure	101.3250 kPa
Flowing Temperature	10.0000 °C
Base Temperature	15.5556 °C
Differential Pressure	10.0000 kPa
Permanent Pressure Loss	0.0000 kPa

CalPac Result	
Volume Flow Rate at Pb, Tb	0.0000 E3M3/day
Volume Flow Rate at Pf, Tf	0.0000 m³/hr
Mass Flow Rate	0.0000 kg/sec
Energy Flow Rate at Pb, Tb	0.0000 GJ/d
Velocity	0.000000 m/sec
Pipe Reynold's Number	0.00

Result-Gas-Flow Calculations	
Volume Flow Rate at Pb, Tb	0.0000 E3M3/day
Volume Flow Rate at Pf, Tf	0.0000 m³/hr
Mass Flow Rate	0.0000 kg/sec
Energy Flow Rate at Pb, Tb	0.0000 GJ/d
Velocity	0.000000 m/sec
Pipe Reynold's Number	0.00

Properties

Intelligent Metering System - Maintain the performance



Method for Analyzing Diagnostic Information

Meter Functional Diagnostics

- Gains (dB)
- Signal-to-Noise Ratio
- Performance (%)
- Structural Integrity

Process Condition Diagnostics

- Turbulence (%)
- Profile Factor
- Symmetry
- Cross flow
- Swirl Angle
- Drive Gain
- Density

Measurement Integrity Diagnostics

- AGA-10 SOS comparison
- Structural Integrity data comparison
- Measured / calculated density comparison
- Independent GC, PT, TT and DT checks and calibrations

- Pro-active monitoring of key meter, instrument, and system parameters will alarm as these key parameters drift outside of a certain range or exhibit unusual drift over time.
- Periodic review of system health to ensure that everything looks healthy, no unusual parameter drift is occurring, and calibration certificates are up to date
- Let the system tell you when calibration is needed.

Centralized Data & Improved Work Practices



Intelligent Systems Applications Drive Top-Quartile Results and Bridge System Health to Connected Services



Cloud

Plantweb Advisor – Metrology

- Coriolis SMV
- Ultrasonic CBM
- GC CBM (Gas Systems)

Connected Services– Custody Transfer

- Exception Monitoring / Reporting
- Expertise on Demand
- Calibration Services
- Maintenance Services
- Metrology as a Service

Engineering /
Operator
Workstation

Secure First Mile
SSL Encryption
MQTT

Flow
Computer

Local Data
Server

Firewall

I/O Controller

Plantweb Advisor – Metrology

- Coriolis SMV
- Ultrasonic CBM
- GC CBM (Gas Systems)

Customer Maintenance Team

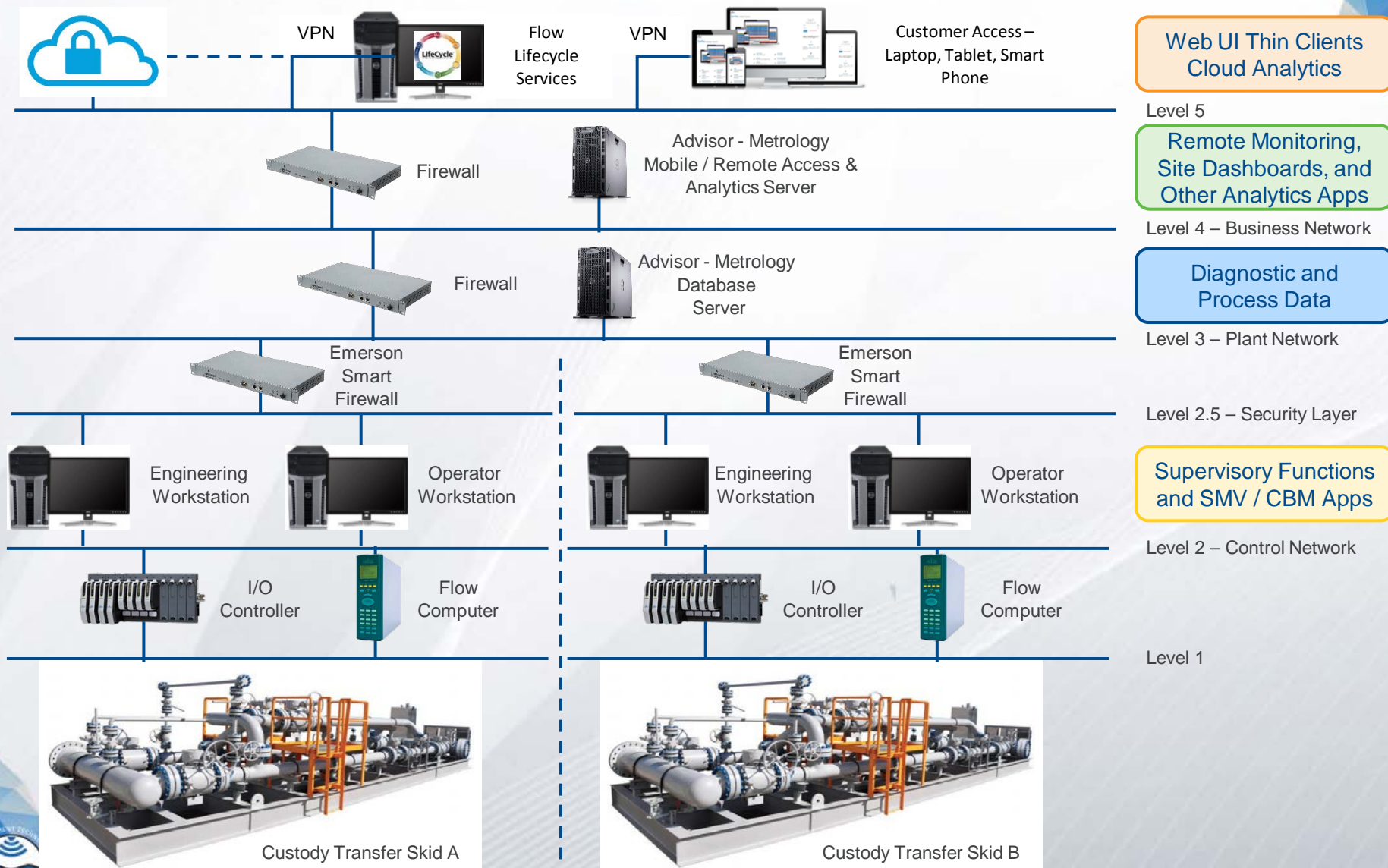
- Remote Diagnostic Access / Triggers
- Mobile Device Accessibility
- Persona-Based Dashboards

Control
Room

Business
Network

Skid

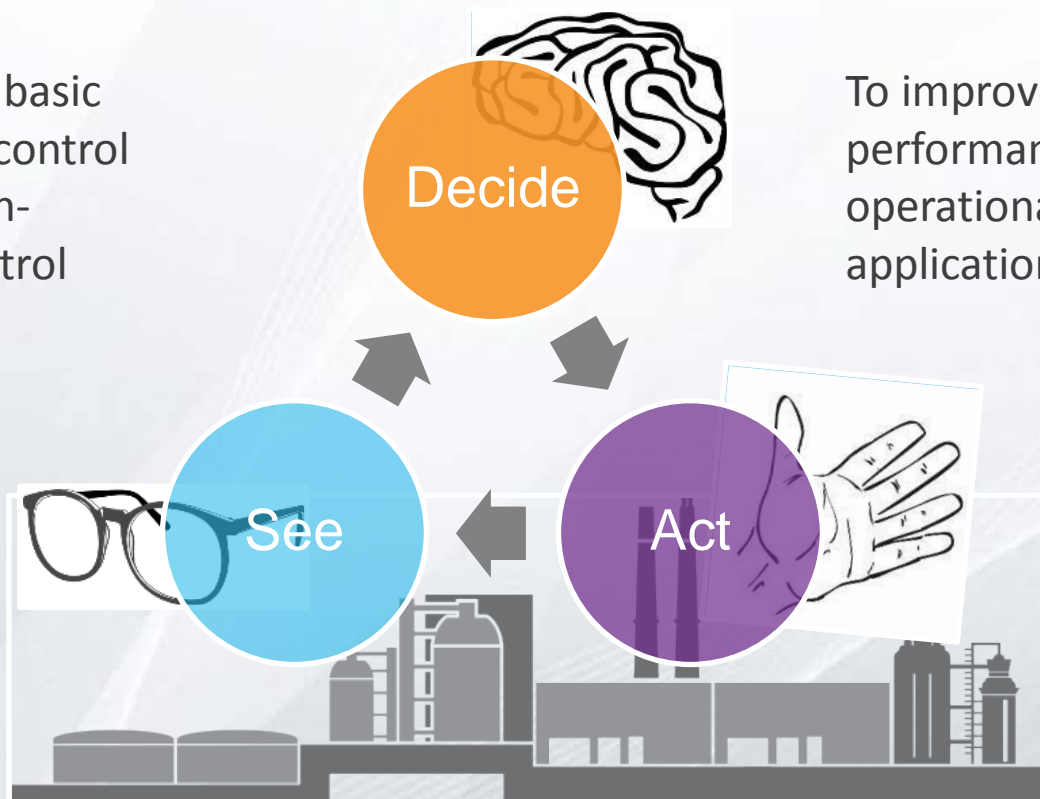
Data Security and Integrity is Paramount to Ensuring Effective Remote Monitoring



See-Decide-Act

Use the same basic approach we control processes with-
Feedback Control

To improve performance in all operational application areas





Thanks for Attention