

Flow Measurement Best Practices For Reliable Solutions and Optimum Performance

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8 April 2016

Performance Without Compromise



Agenda

- Engineered Flow Systems and Solutions for Reliability
- Best Practices when Selecting Flow Products
- Optimum Performance with Flow Life Cycle Services
- Corrosion & Erosion Solutions

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- Best Practices when Selecting Flow Products
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Flow Measurement Group



8,000 Employees
Focused on Flow
Solutions



1000 Years of Flow
Measurement
Experience



In more than
150 Countries
Around the World

Flow Systems

Delivering Engineered solutions
Meet market needs

Hardware integration, intelligent
operation, turnkey and automation
systems



- Well Production Management Applications
- Crude & Multiproduct Pipelines
- Refined Product Transfers
- Loading/Unloading Systems
- Petrochem/Chemical allocation & transfers

Flow Products

Best Practice Flow Products

Best technology, field-proven best
practices and device data



Flow Services

Supporting Complete Lifecycle
of Customer's Solutions

Maintenance, commissioning,
consulting and asset health services



Flow Systems and Solutions



Liquid Metering System with Bi Direction Ball Prover



Gas USM Metering Skid



LNG/LPG/Refined Loading System



DanPac Supervisory Control System



Surge Relief System



Truck Loading



Compact Prover



Low Gas Void Fraction Wellhead



Wet Gas Wellhead Metering



Chemical Injection



Being A Flow Trusted Advisor

Flow Systems

Hardware integration, intelligent operation, turnkey and automation systems

Core team of Engineers from Project Manager to Engineers to Contract Admin

Understanding of All Applicable standards and Local Requirements

Adopting Best Practices and utilizing latest Design Tools

Flow Technologies

Best technology, field-proven best practices and device data

Original Manufacturer for A Wide Range of flow technologies

Direct Support from Factory (Latest update and Revision) Product Life Cycle

In depth understanding of Application and Best Practices

Flow Services

Maintenance, commissioning, consulting and asset health services

Region Service Team trained by Factory to ensure Quick and effective Respond

System trained which allows them to perform services from field to control room

Maintaining System Reliability and Availability from FAT to end of System Life Cycle

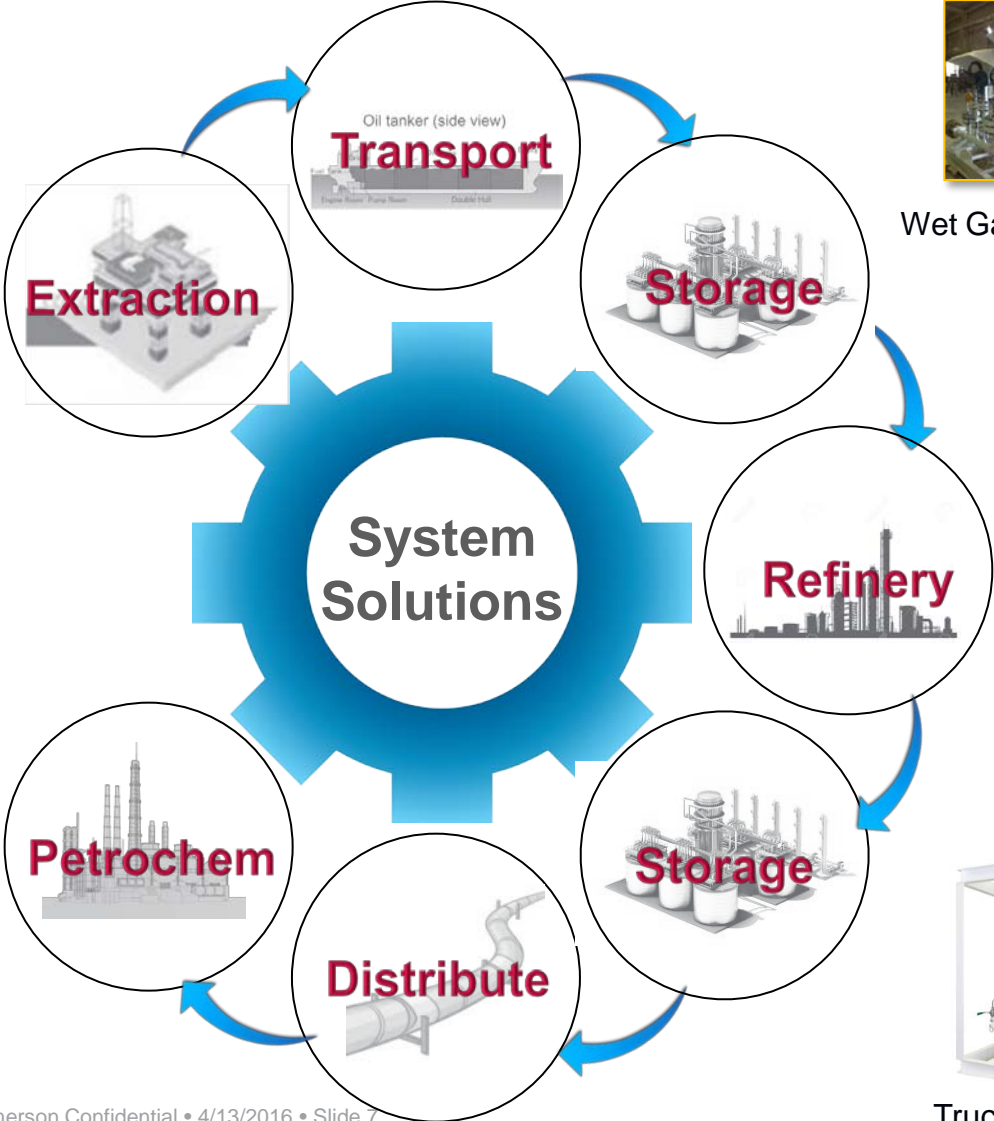
Platform to Being a Flow Trusted Advisor

Identify fit for purpose technology, Streamlined proven technology and designs in meeting customer needs and maintaining the “As Built” Condition throughout the system life cycle

Industries Driven Solution



Solving the process industry's toughest challenges with predictable success any time, any place



Wet Gas Wellhead



Surge Relief System



Fiscal/Allocation



Truck Loading

Emerson Technologies

Integrating Emerson industry leading products into Measurement Systems Solutions with single point of responsibility

■ Controls

- DeltaV
- Bristol
- FlowBoss
 - S600+
- ControlWave
- ROC
- Roxar
- Daniel
 - DanPac

■ Valve

- Fisher
 - Globe Valve
 - Posi-Seal
- Virgo
- Francel
- Tartarini
- TESCO
- Daniel

■ Instrumentation

- Rosemount



■ Analyzers

- Rosemount Analytical
 - Gas Chromatographs
 - Liquid
- ROXAR
 - Watercut
- Micro Motion
 - Density & Viscosity

■ Services

- FAT
- SAT
- Life Cycle Care

■ Flow

- Daniel
- Micro Motion
- Rosemount Flow

■ Valve Automation

- Fisher
 - Baumann
- EI-O-Matic
- Hytork
- Shafer
- Bettis
- FieldQ
- Dantorque
- EIM
- TopWorx

Flow Trusted Advisor Adopting Best Practice Solutions

Flow Trusted Advisor Collaboration and Partnership to Optimize *Budget, Schedule, and Performance*

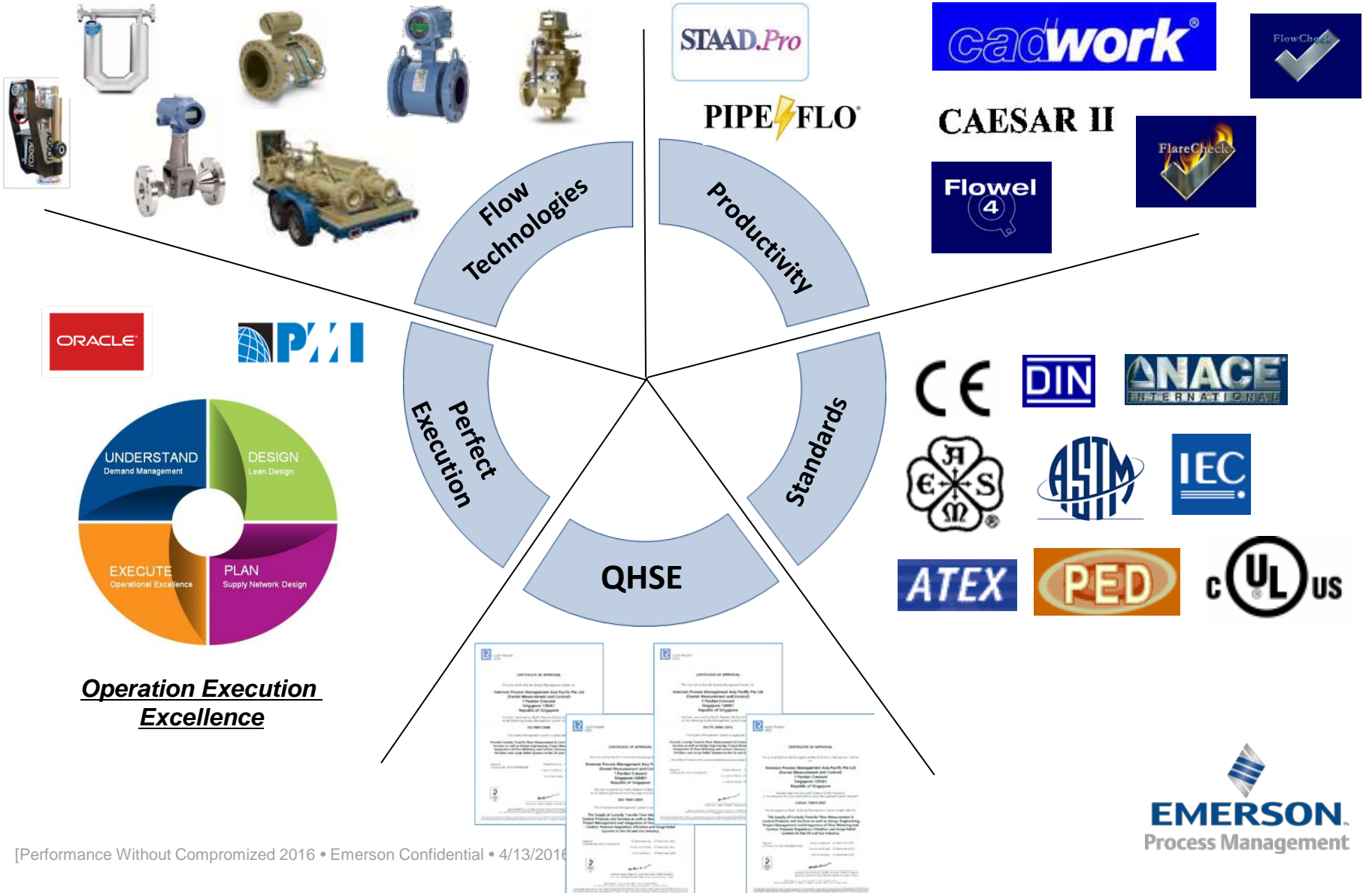
- Fit-for-purpose flow technology
- Latest technology in System Design



- Project Execution Excellence
- Resources and Coverage

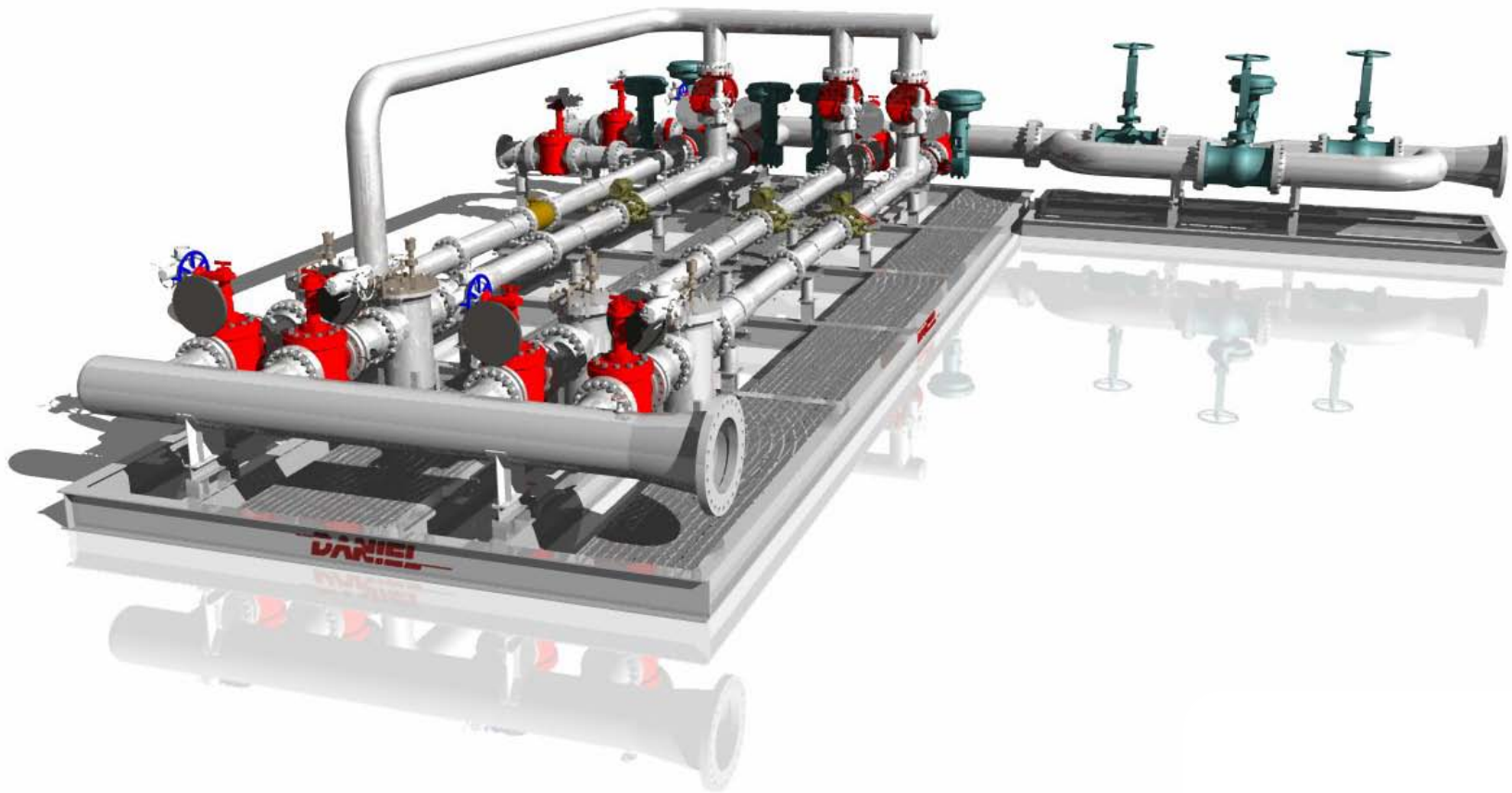
- Technology Optimization
- Off-load Project Effort
- Eliminate Overdesign

Best Practice in System Design



Best Practices in Leveraging Latest in Design Tools

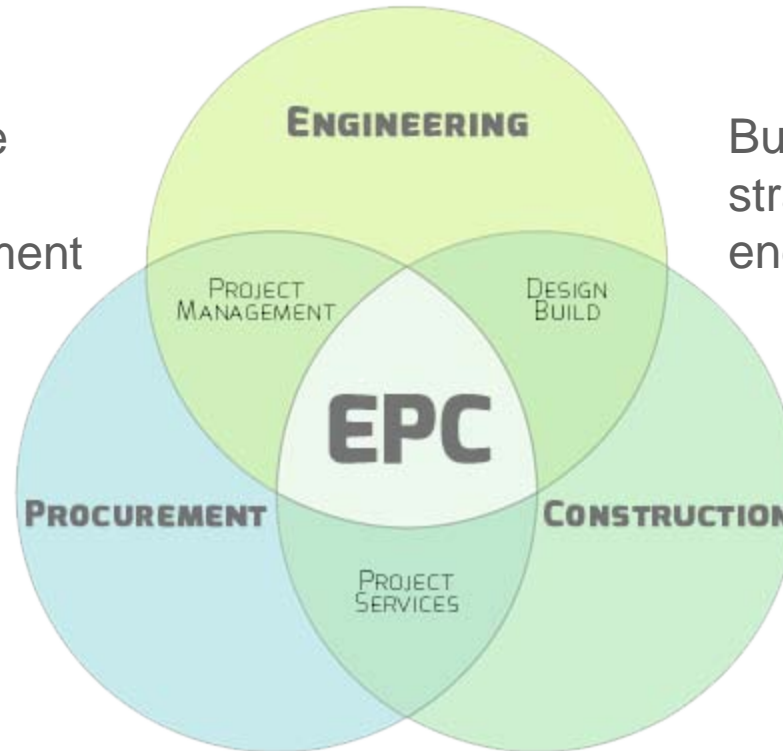
3D Drawing – Used in Design Freeze Meeting to finalize layout before commencement of fabrication



Best Practices in Risk Management in Project Execution

Scope

Technical Compliance Risk - Differentiate as design and measurement experts



Cost

Budget Risk - Simplify design strategy and minimize overall engineering and capital costs

Delivery

Schedule Risk - Secure faster project completions, installations, commissioning, and hand-over

Quality Assurance



CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

**Emerson Process Management Asia Pacific Pte Ltd
(Daniel Measurement and Control)
1 Pandan Crescent
Singapore 128461
Republic of Singapore**

has been approved by Lloyd's Register Quality Assurance to the following Quality Management System Standard:

ISO 9001:2008

The Quality Management System is applicable to:

Provide Custody Transfer Flow Measurement & Control Services as well as Design Engineering, Project Management, Integration of Flow Metering and Control, Pressure Regulation, Filtration and Surge Relief Systems to the Oil and Gas Industry

Approval Certificate No: SNG 0160288/QMS
Original Approval: 27 December 2006
Current Certificate: 27 December 2015
Certificate Expiry: 27 December 2018



Issued by: Lloyd's Register Quality Assurance Limited Singapore

Head Office: 100 Brook Street, London, W1B 3LY, United Kingdom
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has been approved by Lloyd's Register Quality Assurance to the following Quality Management System Standard:

ISO/TS 29001:2010

The Quality Management System is applicable to:

Provide Custody Transfer Flow Measurement & Control Services as well as Design Engineering, Project Management, Integration of Flow Metering and Control, Pressure Regulation, Filtration and Surge Relief Systems to the Oil and Gas Industry

This certificate forms part of the approval identified by certificate number SNG 0160288/QMS

Approval Certificate No: SNG 0160288/29K
Original Approval: 11 December 2006
Current Certificate: 01 December 2015
Certificate Expiry: 28 December 2018

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Singapore 128461
Republic of Singapore**

has been approved by Lloyd's Register Quality Assurance to the following Environmental Management System Standard:

ISO 14001:2004

The Environmental Management System is applicable to:

The Supply of Custody Transfer Flow Measurement and Control Products and Services as well as Design Engineering, Project Management and Integration of Flow Metering and Control, Pressure Regulation, Filtration and Surge Relief Systems to the Oil and Gas Industry

Approval Certificate No: SNG 0190092/EMS
Original Approval: 27 December 2006
Current Certificate: 27 December 2015
Certificate Expiry: 14 September 2018



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CERTIFICATE OF APPROVAL

This is to certify that the Occupational Health & Safety Management System of:

**Emerson Process Management Asia Pacific Pte Ltd
(Daniel Measurement and Control)
1 Pandan Crescent
Singapore 128461
Republic of Singapore**

has been approved by Lloyd's Register Quality Assurance to the following Occupational Health & Safety Management System Standard:

OHSAS 18001:2007

The Occupational Health & Safety Management System is applicable to:

The Supply of Custody Transfer Flow Measurement & Control Products and Services as well as Design Engineering, Project Management and Integration of Flow Metering and Control, Pressure Regulation, Filtration and Surge Relief Systems to the Oil and Gas Industry.

Approval Certificate No: SNG 0190092/OHSAS
Original Approval: 27 December 2006
Current Certificate: 27 December 2015
Certificate Expiry: 26 December 2018



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Example : Terminal - Save CAPEX & OPEX using Best In Class Precision Flow Products

	PD	Turbine	USM	Coriolis
Varying Fluid Properties				
Maintenance				
Long Term Stability				
Entrained Air				
Bidirectional Use				
Diagnostic Capabilities				

Best Practice Flow Technologies



Daniel Ultrasonic Flowmeters

- 2012 Control Engineers' Choice Award



Micro Motion Coriolis Flowmeters

- First commercial coriolis meter
- 2015 Innovation Award
- 2015 Control Readers' Choice Award

	CMFHC2	CMFHC3	CMFHC4
Typical Flow (Barrels per Day)	80,000	140,000	215,000
Value of Crude Oil Measured per Day (@ \$52 per BBL)	\$4.2M	\$7.3M	\$11.2M
Value of 0.1% error per Day	\$4,200	\$7,300	\$11,200
Minutes of Flow = Price of Meter	20 min.	15 min.	15 min.

“Companies **re-spend 450 percent of their initial automation investment over the life of the well due to reworks and ongoing maintenance**” – ARC



Flow Measurement Systems Experience

Over 5000 flow measurement systems worldwide for Oil & Gas companies



Agenda

- Engineered Flow Systems and Solutions for Reliability
- Best Practices when Selecting Flow Products
- Optimum Performance with Flow Life Cycle Services
- Corrosion & Erosion Solutions

Flow Best Practices for Process Applications

- Range of Products support flow best practices
- Minimize pressure loss to decrease pumping cost
- Minimize piping requirements to reduce installation costs
- Eliminate impulse lines to increase availability, accuracy and safety
- Reduce installation costs by selecting in-line meters for small line sizes and insertion for large line sizes
- Diagnostic capabilities

Flow Products

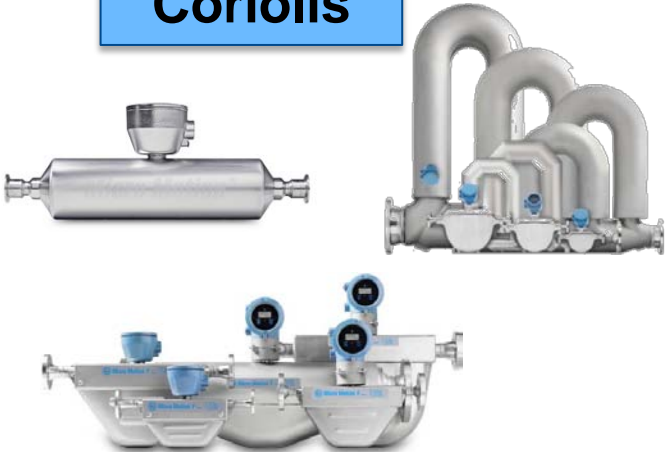
Ultrasonic



Orifice



Coriolis



Averaging Pitot



Vortex

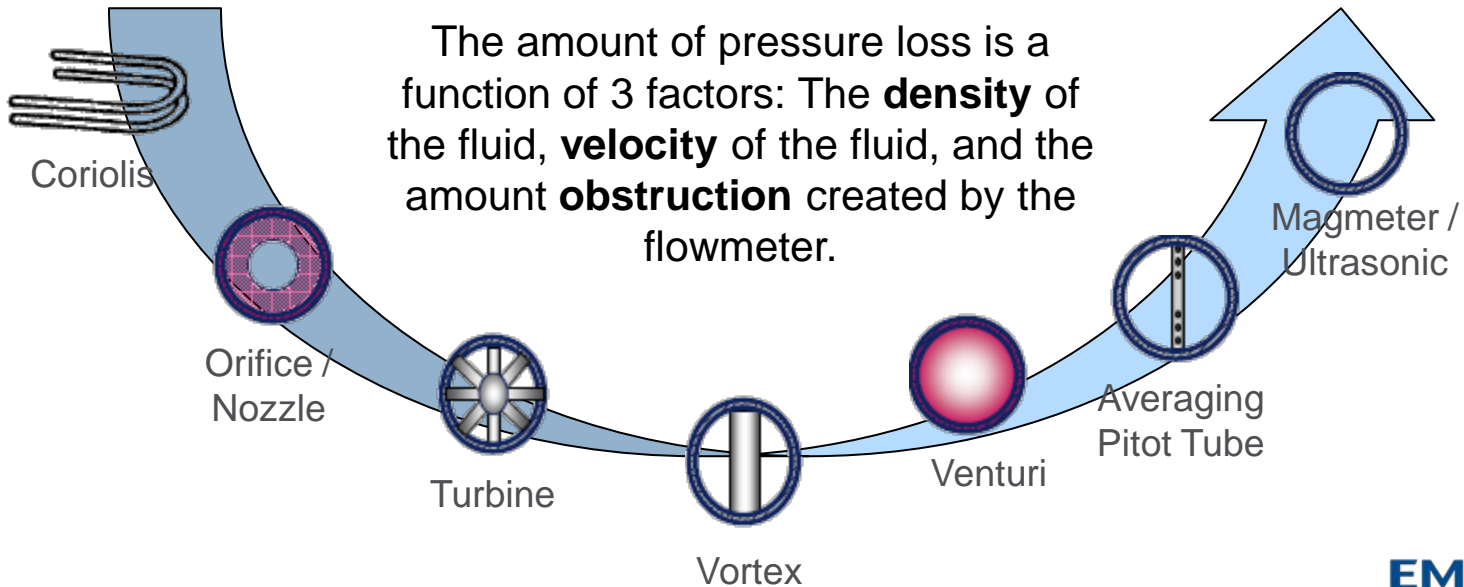
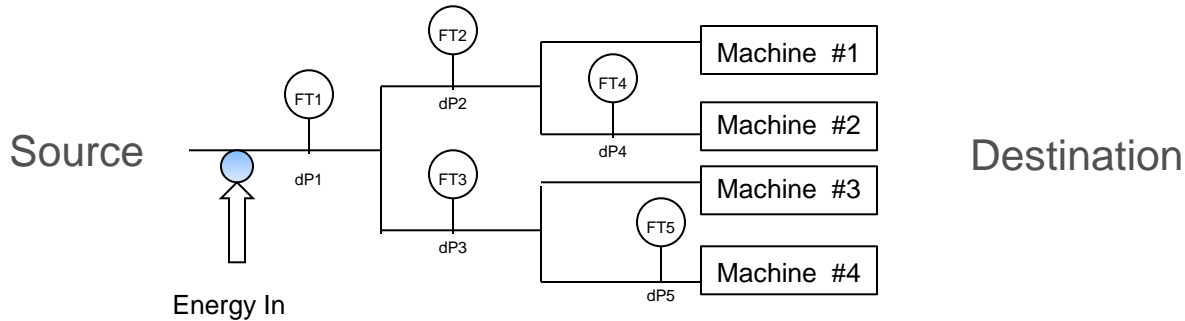


Magnetic

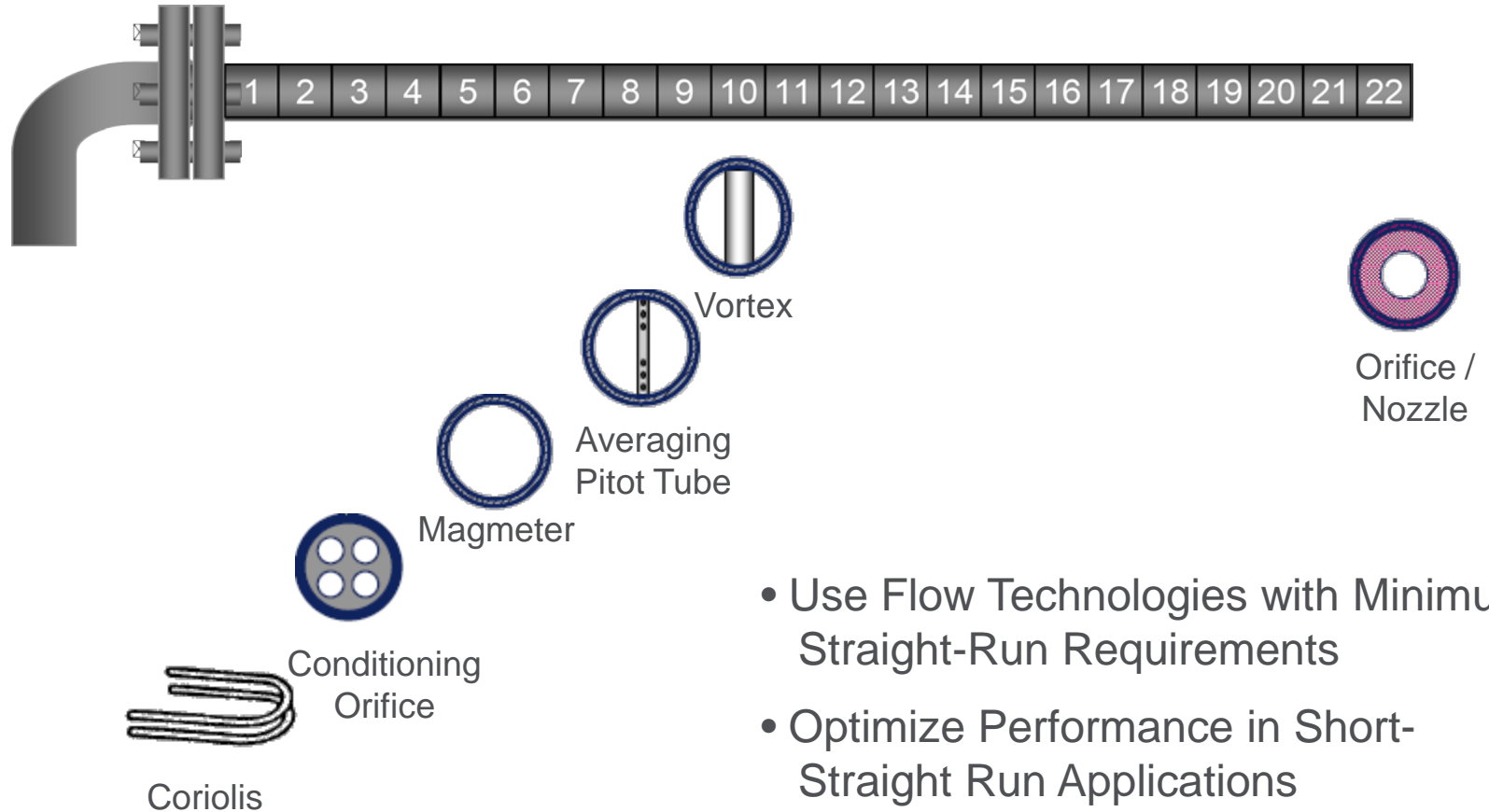


Pressure Loss Consideration

Pressure at Destination < Pressure at Source



Minimize Piping Requirements



- Use Flow Technologies with Minimum Straight-Run Requirements
- Optimize Performance in Short-Straight Run Applications
- Size/Select Primary Element to Avoid Needed Reducers

Eliminate Impulse Lines

Traditional Installation



Potential Leak Points = 36

- Leak Points
- Tendency to Plug / Freeze
- Inconsistent Measurement

Best Practice Installation



Potential Leak Points = 2

Potential Leak Points = 4

Potential Leak Points = 8

Potential Leak Points = 2



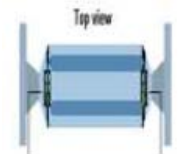
Single Casting



Obstruction less



No Internal Tubing

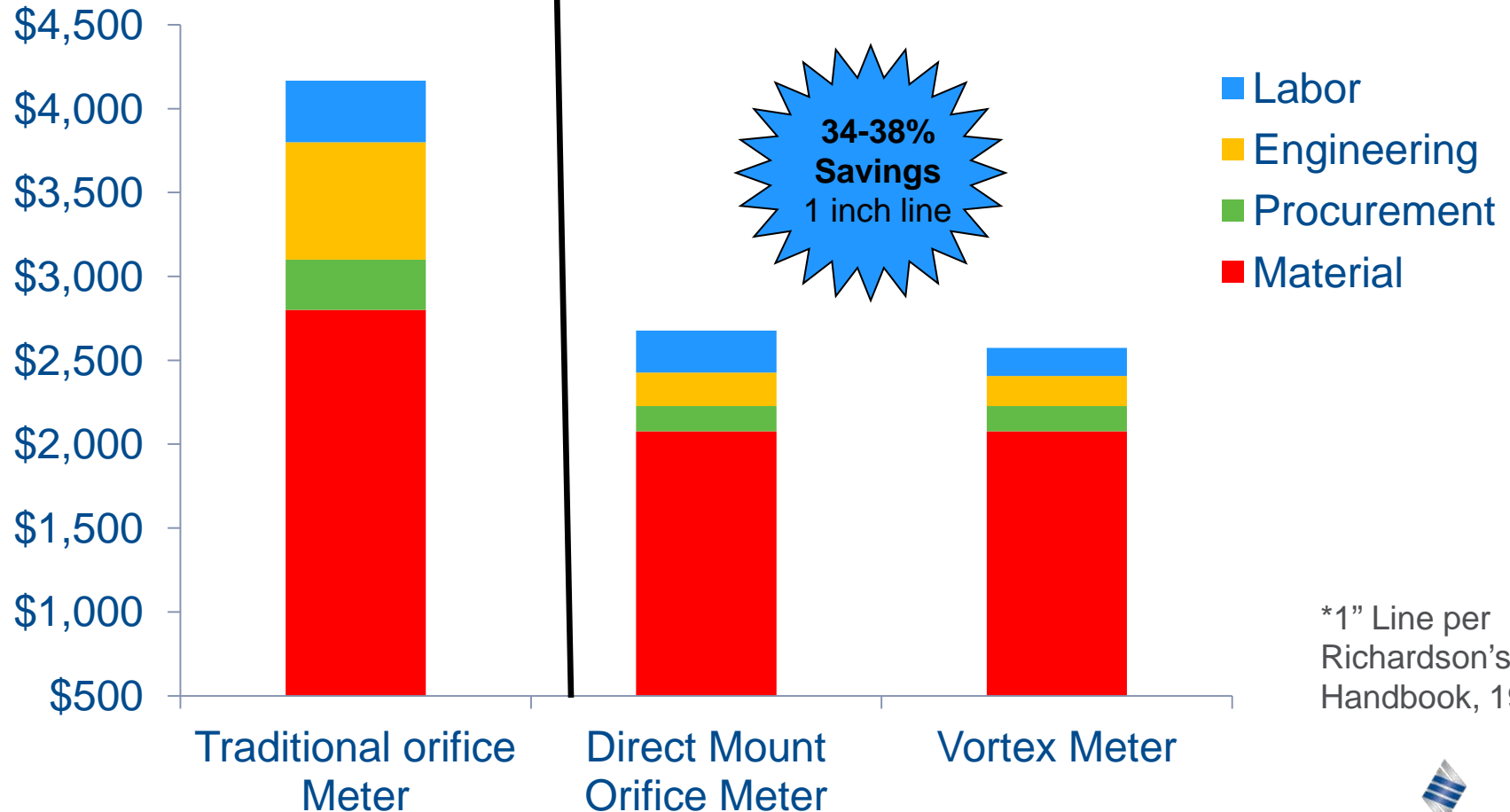


Proven Reliable

Select Inline for Small Line Sizes

Traditional Installation

Best Practice Installation

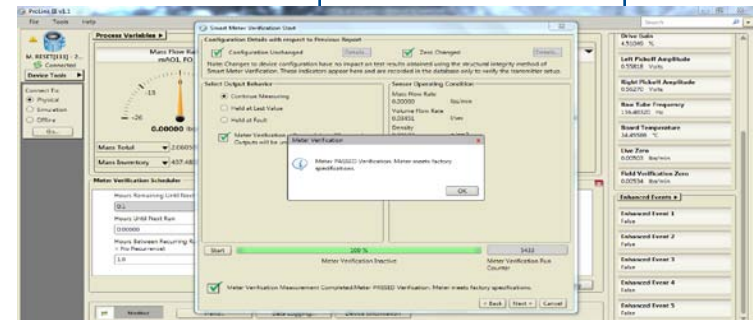
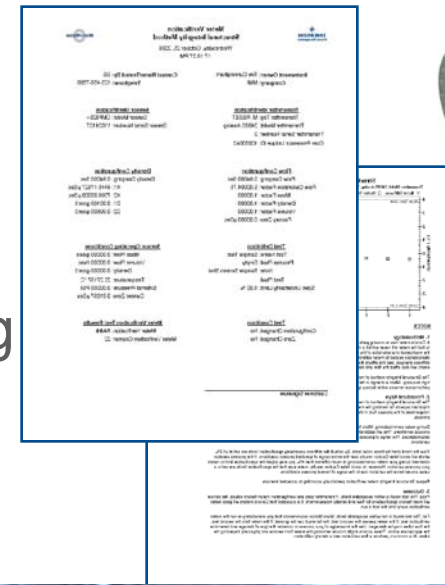


*1" Line per Richardson's Handbook, 1997



Diagnostic Capabilities – Meter Verification

- Verification of the Entire Meter
Sensor + Transmitter + Connections
- Improves Output
 - Does not impact Availability
 - Improves Quality & Throughput
- Reduces Maintenance Costs
 - Simplifies Verification & Troubleshooting
 - No extra equipment or trips to the field
 - Improves Safety
- Complete Test Traceability
 - Wireless & AMS
- Emerson Patented Technology*



* - Patent Pending

Agenda

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- Best Practices when Selecting Flow Products
- Optimum Performance with Flow Life Cycle Services
- Corrosion & Erosion Solutions

Emerson Flow Lifecycle Services Portfolio

MAINTENANCE



- Certified Repair / Demand Services
- Spare Part Management
- Tech-Support & Live Chart

RELIABILITY



- Product & System Start-Up & Commissioning
- Product & System Upgrading
- Calibration Services
- Meter Refurbishment
- Preventive Maintenance
- Product & System Educational Services
- Smart Meter Verification

PERFORMANCE



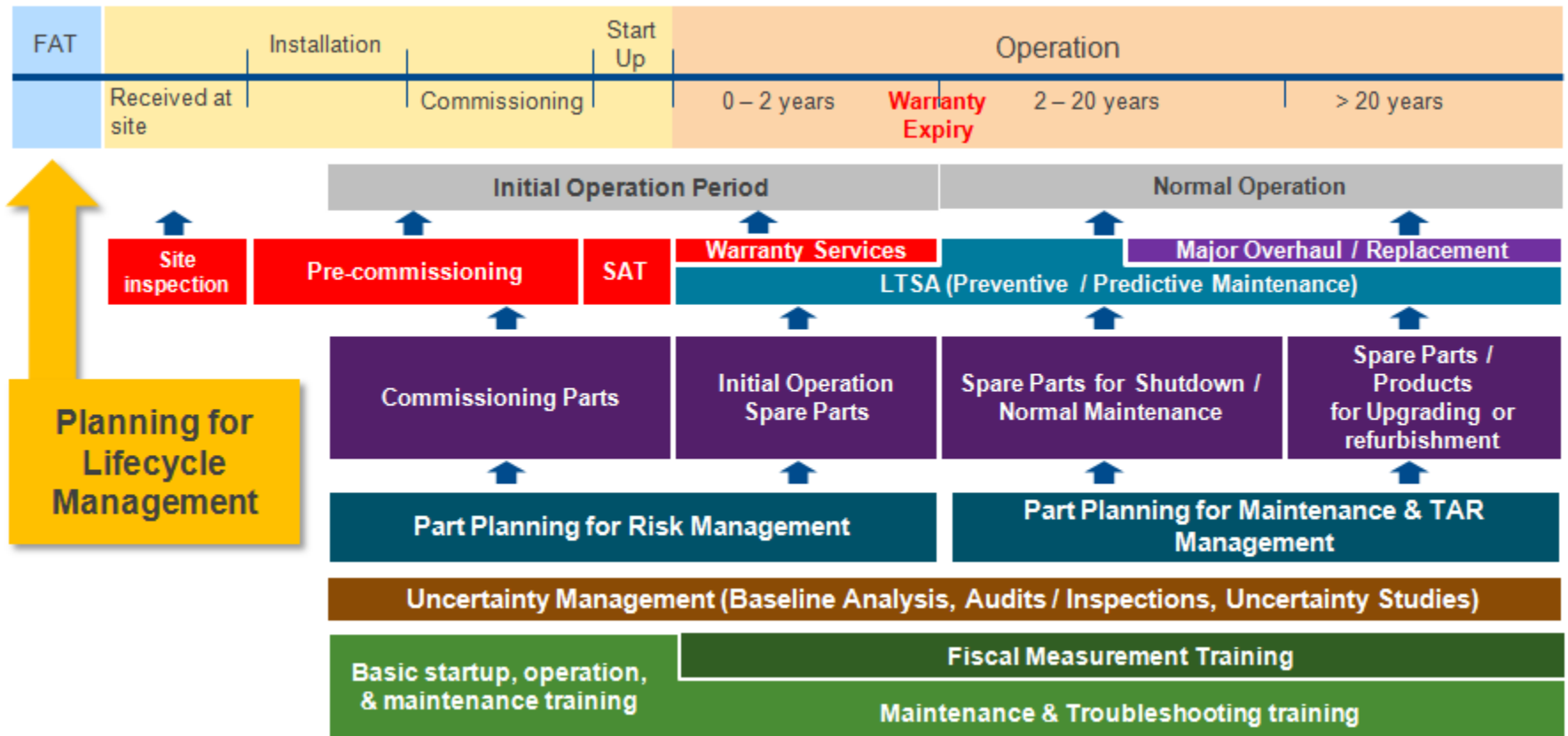
- Meter Tube Inspection
- Meter Audit Services
- Uncertainty Study
- Data Verification
- Consultancy Services
- Remote Monitoring & Condition Based Monitoring
- Metering & Process Educational Services
- Develop Manual and work Procedures

Precision Flow Product Services

Flow System & Solution Services

Lifecycle Management

Typical Lifecycle of a Flow Metering System



Early lifecycle planning critical for Reliability & Performance management in the initial & normal operations period

Installation, Startup & Commissioning Assistance



Installation assistance and supervision

- Unloading at site
- Skid installation and assembly
- Mechanical hook-up
- Electrical hook-up
- Panel installation
- Analyzer shelter installation
- Sampling system installation



Pre-commissioning expertise

- Test procedures
- Equipment hire
- Field cabling checks
- Loop checks
- Metering system communications testing
- DCS / SCADA link commissioning
- Transmitter functional checks
- Valve hook up and testing
- Prover pre-commissioning



On-site acceptance testing & Startup

- Loop accuracy checks
- Flow Computer ADC / DAC checks
- Configuration checks
- System Function checks
- Proving
- Flow balancing
- Line switching
- Calculation Checks
- Totalization Checks
- Start-up assistance to ensure satisfactory operation & compliance



Training & Competency Development

- Instrument maintenance & troubleshooting
- Metering system operations
- Fiscal measurement best practices

Warranty Support

- Emergency replacements
- Extended warranties optional

Ensures Reliable & timely startup

Maintenance regime for Custody Transfer systems during initial 2 operating years



Monthly / Bi-monthly Validations

Pressure & Temperature Validation

Analyzer validation & calibration

Flowmeter health check & visual inspection

Flow computer calculation check & ADC calibration

Meter proving



Half yearly Validations

Flow Computer integration check at multiple operating conditions

Analyzer preventative maintenance (quarterly / half yearly)



Yearly Validation

Prover recertification

Meter tube inspection

Analyzer major services

Annual Metering Audit

Wet Calibration

Preventative Maintenance contract during initial operating years will help establish confidence on measurements

Long Term Service Contracts – Fiscal Measurement Systems

Shwe Onshore & Offshore Gas Terminals

- Preventative Maintenance of metering system
- Validation & Calibration Services
- Educational Services
- Bi-monthly PM visits



MYANMAR

Total Onshore & Offshore Terminals

- Preventative Maintenance of metering system
- Annual Validation Services
- Orifice & Meter tube Inspections
- Spare parts support



MYANMAR

Binh Son Refinery – Jetty loading terminal

- Preventative Maintenance of metering system
- Meter proving & Validation Services
- Validation of Compact & Pipe provers
- Educational Services



VIETNAM

Carigali HESS Operating Company

- Preventative Maintenance of metering system
- SOF, Flow Computers, Gas Chromatographs
- Annual
- Priority On-site service & parts delivery



MALAYSIA

Performance Services by METCO

ACCREDITED AUDITS

- Review Measurement
- Check Risk
- Corporate reputation
- Identify improvement



METERING CONSULTING

- Uncertainty Studies
- Standards, best practices
- Develop Operating Procedures
- Allocation Procedures



METCO

- Capture and Correct
- Validate and prevent
- Management and plan



MEASUREMENT OPERATIONS

- Oil & Gas Fiscal Measurement Trainings
- SVQ Certification Program



COMPETENCY DEVELOPMENT

Create a Seamless, Easy Experience Through Processes & Systems, Organization and Metrics

Meter Performance Checks

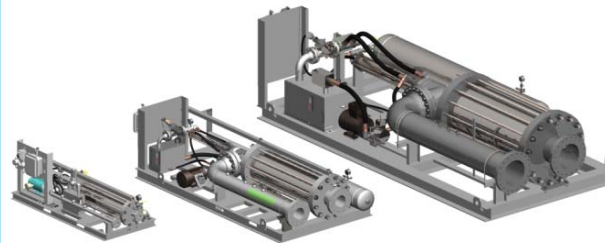
Verification

- Checks all meter elements: sensor components, tube stiffness, electronics, and wiring
- Test can be done in-situ and on-line (no down time)
- Requires entire meter to be repeatable and functioning correctly



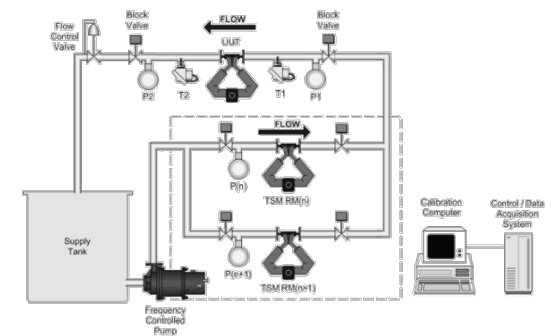
Validation

- Confirming flow performance by comparing a primary flow standard to sensor
- Typically in-situ
- Optional Methods
 - Weigh Scale
 - Master Metering (API 4.5)
 - Proving (API 4.2)



Calibration

- Comparing and correcting based on a reference standard
- Calibration is done on new/used meters
- Can also be done at our regional Service Centers
- Flow lab & Service Centers maintains full traceability and accreditation of all calibration facilities.



Southeast Asia Flow Calibration & Service Centre offers Factory Standard Services

Singapore

Flow Calibration Stand Specification

Flow Range	1.81 kg/min to 3000 kg/min
Process Connection	½ inch to 4 inch 15mm to 100mm
Calibration Media	Water
Methodology	TSM (Transfer Standard Method)
Uncertainty	Mass Flow : ±0.050% of rate Liquid Density : ±0.15 kg/m ³ Volume Flow : ±0.053% of rate
Certificates	Factory Standard Certificate OR ISO/IEC 17025 Certificate
Accreditation	ISO/IEC 17025 Singapore Accreditation Council
Weights & Measures	Authorized Verifier Status by SPRING Singapore



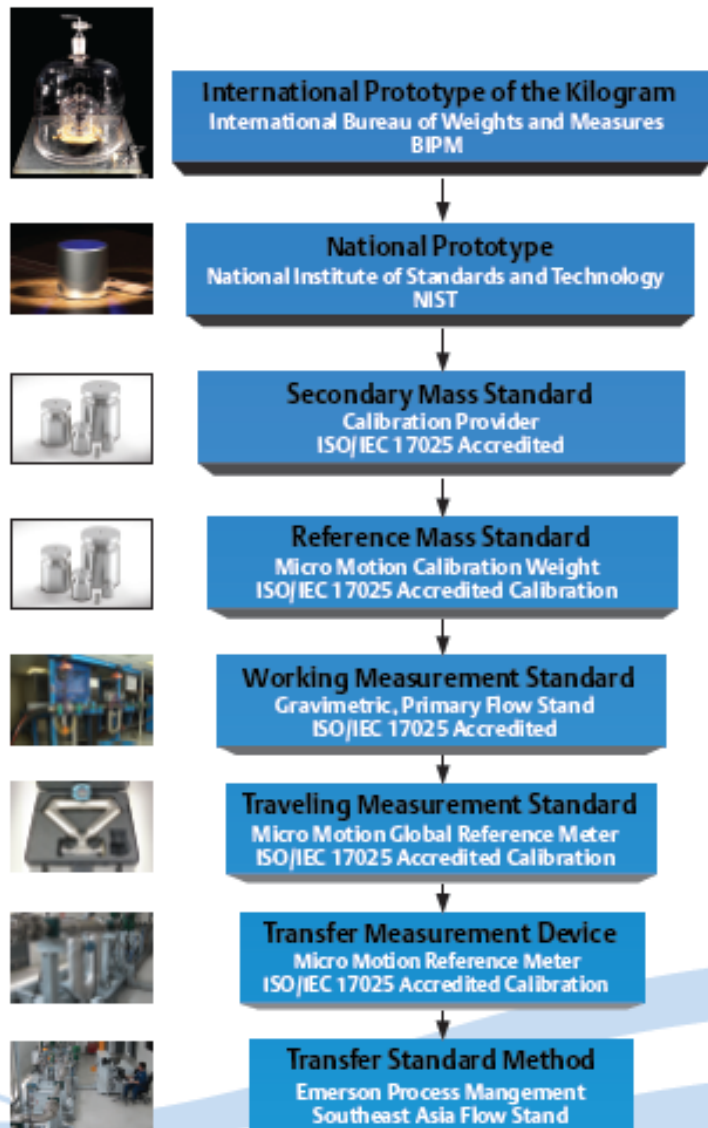
Certified & Traceable Flow Calibrations & Repair Services

- Liquid Flow & Density Calibrations
- NIST / BIPM Traceability
- Primary Product Analysis

Local Calibration Services offers Fast Turnaround & Emerson Flow's Global Quality

Our Southeast Asia Flow Calibration Lab is traceable to NIST

Singapore



Traceability Maintained through:

- Annual Inter laboratory testing
- Monthly Gold Meter testing
- Accreditation through annual assessments by Accreditation body

Agenda

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- Best Practices when Selecting Flow Products
- Optimum Performance with Flow Life Cycle Services
- Corrosion & Erosion Solutions

Pipeline Integrity And Asset Management Strategies Address Critical Industry Trends



Site Safety

- Ageing Infrastructure
- Environmental cost associated with leaks or spills



Reliability

- Loss of production
- Corrosion Sizeable Portion of Maintenance Expenditure
- Sand production increases with ageing fields



Ageing workforce

- Local Lifecycle Care
- Trusted Advisor



Information

- Process Information and Optimization
- Expansion of production into more demanding environments
- Integrated Solutions

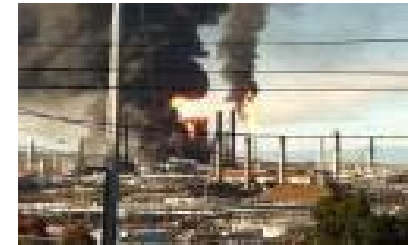
Positive Drivers Support Higher Growth Rates than Overall Oil & Gas Market

Integrity And Reliability Solutions Delivers Value Across Various Industries

Annual Profit Loss Due To Corrosion In US Refineries Alone Can Exceed \$12B*



Ageing Infrastructure Increases Risk of Unscheduled Shutdowns



Cost Of Corrosion per Industry

Oil & Gas Exploration & Production	B\$	1.4
Mining	B\$	0.1
Petroleum Refining	B\$	3.7
Chemical, Petrochemical, & Pharmaceutical	B\$	1.7
Pulp & Paper	B\$	6.0

*Source: NACE

Online Monitoring Enables Knowledge Based Decisions

- Provide **early warning** of asset health degradation and integrity issues
 - Spare equipment can be planned/installed in time to prevent an upset
- **Detect and understand process conditions** that may be creating equipment fault or integrity risk
 - Adjust and optimize process to avoid fault – **optimize production**
- Accurately **determine when service is necessary**
 - No expensive “run-to-failure” or wasted service efforts
- Determine root cause of failure
 - More measurements provide higher probability to identify cause of problem
- **Asset monitoring visibility into the control room**
 - Eliminate unnecessary trips to the field, possibly in hazardous areas



Roxar Value Chain Presence and Applications Overview - Integrity

UPSTREAM

- Flowlines, Export Lines
 - ✓ Corrosion and sand control
 - ✓ Inhibitor control
 - ✓ Production optimization
- General Integrity Management in Carbon Steel Infrastructure
- Data Management Software
- Subsea Infrastructure



MIDSTREAM

- Open and buried pipelines
 - ✓ Low spots, water hold ups
 - ✓ H2S corrosion
 - ✓ Pipeline Integrity
- Continuous data logging
- Solar Power Units
- Communication via terminal, GSM, satellite



DOWNSTREAM

- Utilities and High Temp distillation units
 - ✓ Napthenic corrosion
 - ✓ Water corrosion
 - ✓ Desalination problems
- Opportunity crude programs
- Inhibitor Management
- Integrity Management



Customer challenges are linked to integrity and operational efficiency across all segments

Refinery Industry Increase Their Focus On Integrity Management and Reliability

Integrity For Refineries



Corrosion Measurements

Refinery Infrastructure and Vessels



*Cooling Systems
Side Streams
De-Salting Units
Heat Exchangers
Distillation Units*

- Ageing infrastructure
 - Maintenance & Repair – cost of personnel and hardware
 - Control measures; painting, cladding, repairs, chemical treatment, process adjustments
- Environmental and safety concerns
- Uncontrolled and unplanned shutdowns
 - Production availability
 - Risk to assets, environment and personnel life and health
- Use of opportunity crudes and extended operating envelope of facility
 - More sour crude increases risk of corrosion throughout the facility
 - Drives change in chemical injection programs

As much as 36% of maintenance cost in refineries can be linked to corrosion remediation and repairs

Different Corrosion Challenges Requires A Breadth Of Solutions To Properly Understand The Issues

Proactive Corrosion Control

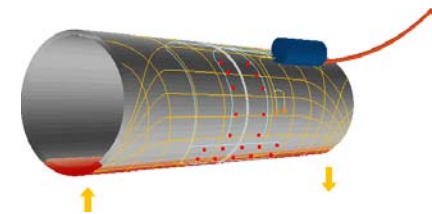
- General corrosion
- Chemical injection optimization
- See the effect of varying crudes
- See changes due to naphthenic corrosion
- **Need fast/high resolution fluid monitoring for immediate response and actions.**



High
Temperature
Probes

Asset Integrity Management

- General and localized corrosion
- Verification of safety and integrity of plant
- Metal loss measurements of critical locations – full pipeline view !
- Input to Risk Based Inspection Planning
- **Need highly accurate pipe wall measurements to understand impact on pipeline integrity**



Field Signature Method

Roxar offers both intrusive (wireless) and non-intrusive technologies (wired)

Typical Corrosion Challenges in Refineries

- Underground corrosion of buried parts of vessels and pipelines
- General and localized internal corrosion in process piping and vessels
- High temperature naphthenic corrosion in distillation units and high temperature process piping
- Corrosion under insulation

Each challenge needs a suitable corrosion monitoring and control strategy – **online monitoring provides greater visibility to corrosion issues across the facility**



Salt in the crude stream presents serious corrosion problems if the desalting unit is not functional

Naphthenic acids in the crude oil cause corrosion problems (NAC).



#1 Flow Measurement Solution Provider

- Metrology Expertise
- Global operation
- Technical Expertise and Industry Experience
- Strong financial standing
- Understanding of the customer requirements
- Expertise on international standards and local regulatory requirements
- Recommend and provide only best practice solutions for flow measurement systems, type tested for compatibility
- Manufacturer of Flow Measurement Technology and critical components of the system
- Strong local presence for Life Cycle support

EMERSON
CONSIDER IT
SOLVED™