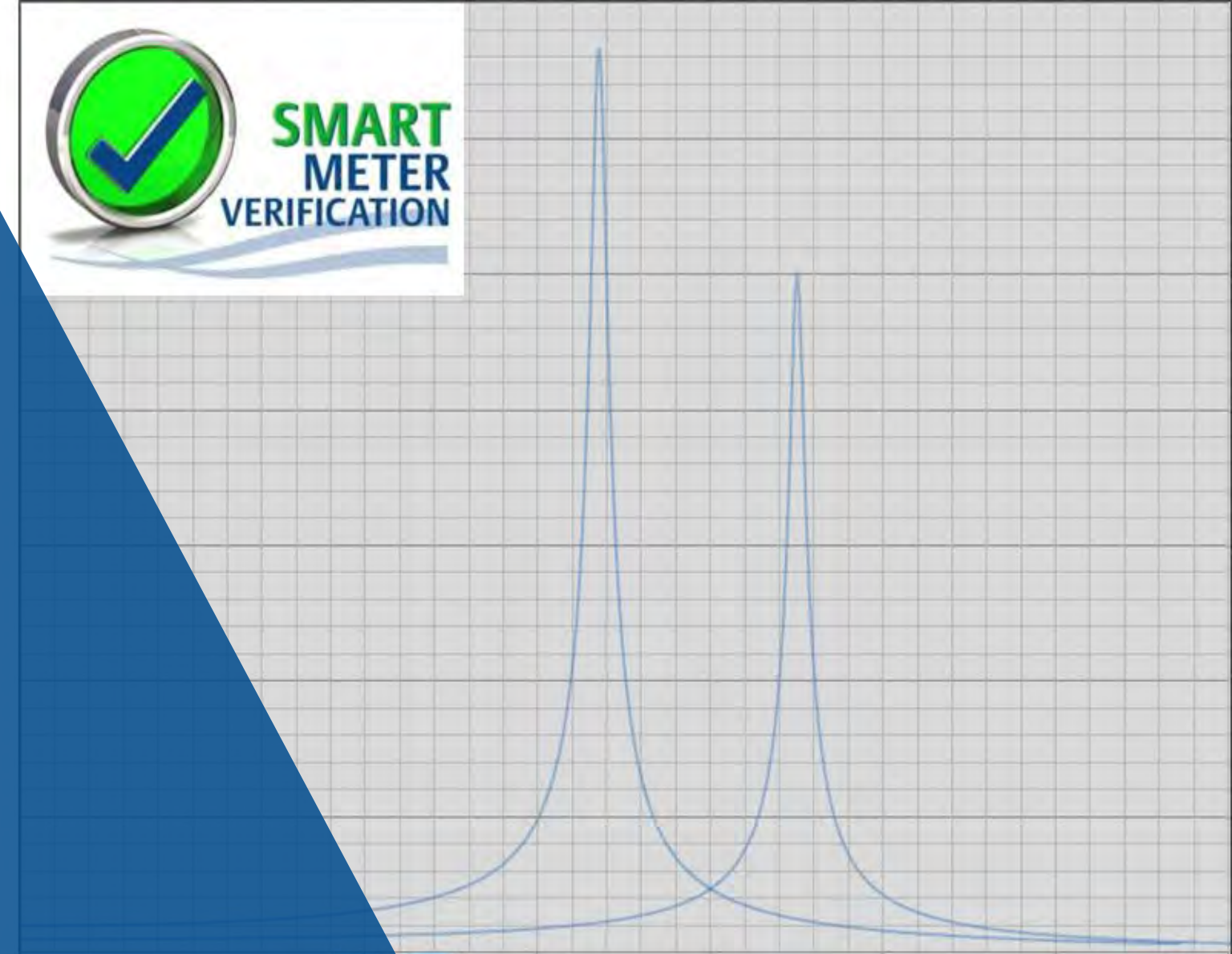




Micro Motion SMART Meter Verification

By Lionel Vilmen

Smart Meter Verification Start

Configuration Details with respect to Previous Report

☒ Configuration Unchanged [Details](#) ☒ Zero Unchanged [Details](#)

Note: Changes to device configuration have no impact on test results obtained using the structural integrity method of Smart Meter Verification. These indicators appear here and are recorded in the database only to verify the transmitter setup.

Select Output Behavior

☒ Continue Measuring

☐ Held at Last Value

☐ Held at Fault

☒ Meter Verification will complete in 90 seconds.

Sensor Operating Condition

Mass Flow Rate	0.00000	kg/hr
Volume Flow Rate	0.00000	l/hr
Density	997.81610	kg/m3
Temperature	5.900	°C
External Pressure	0.00000	PSI

Abort 15 % 3

Initializing Notch Filters

Meter Verification Run Counter

Meter Verification in Progress.

< Back Next > Cancel



Agenda

Introduction to Meter Verification

- Structural integrity method
- Stiffness and mass/ density measurement

SMART Meter Verification (SMV) feature

SMV Basic versus Professional

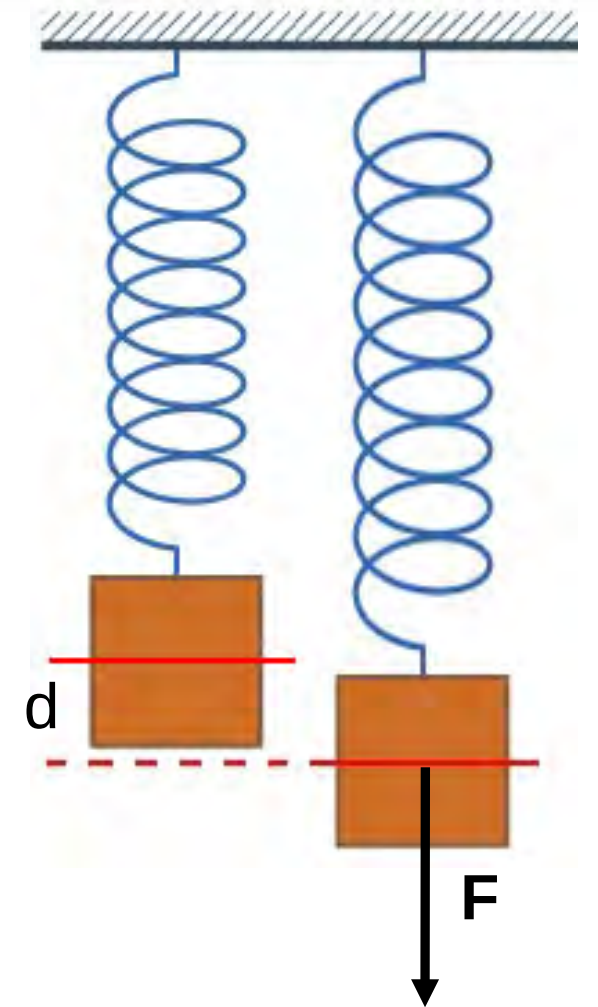
Meter Verification

- Verifies meter is unchanged: Structure is the same as the day it was calibrated and shipped
- Verification is establishing confidence in measurement through the relationship to secondary variables
- Micro Motion uses a secondary variable to verify flow performance
 - Structural Integrity (“Stiffness measurement”)

Stiffness: Definition

- Structural integrity is a measure of the flow tubes strength
- Stiffness is a measure of a structure's integrity and resistance to a load
 - Stiffness is defined as the deflection per unit of load
 - *Stiffness = force/displacement*
 - Stiffness also is a factor in a structure's resonant frequency

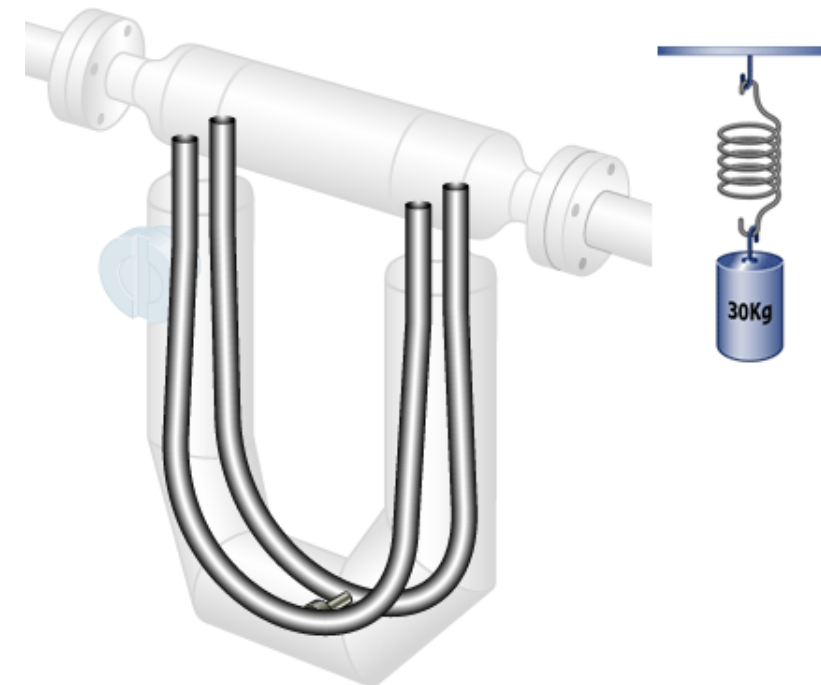
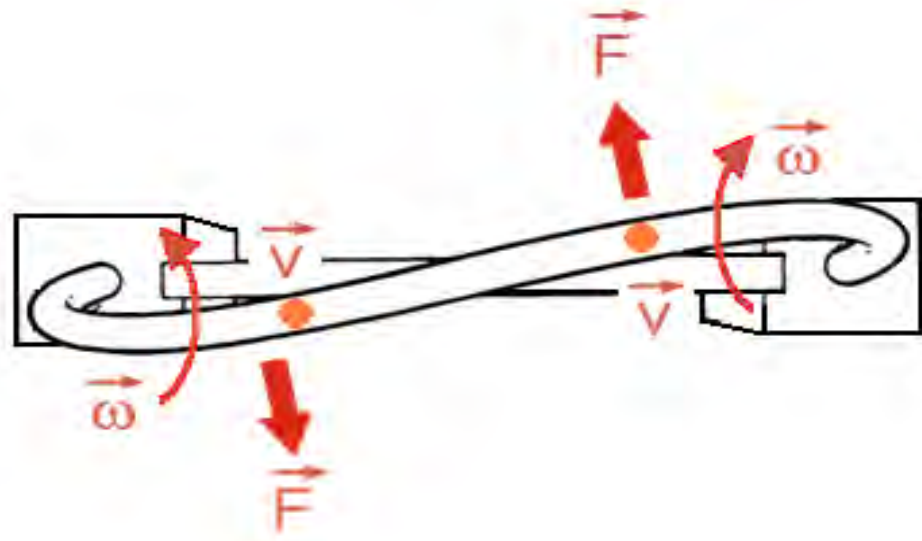
$$\text{Stiffness } K \text{ (N/m)} = \frac{F}{d}$$



EMERSON™

Stiffness: Definition

- Stiffness is a key factor in calibration
- For both density and mass flow
- If stiffness changes, density and flow calibration factors have changed (measurement is altered)



Agenda

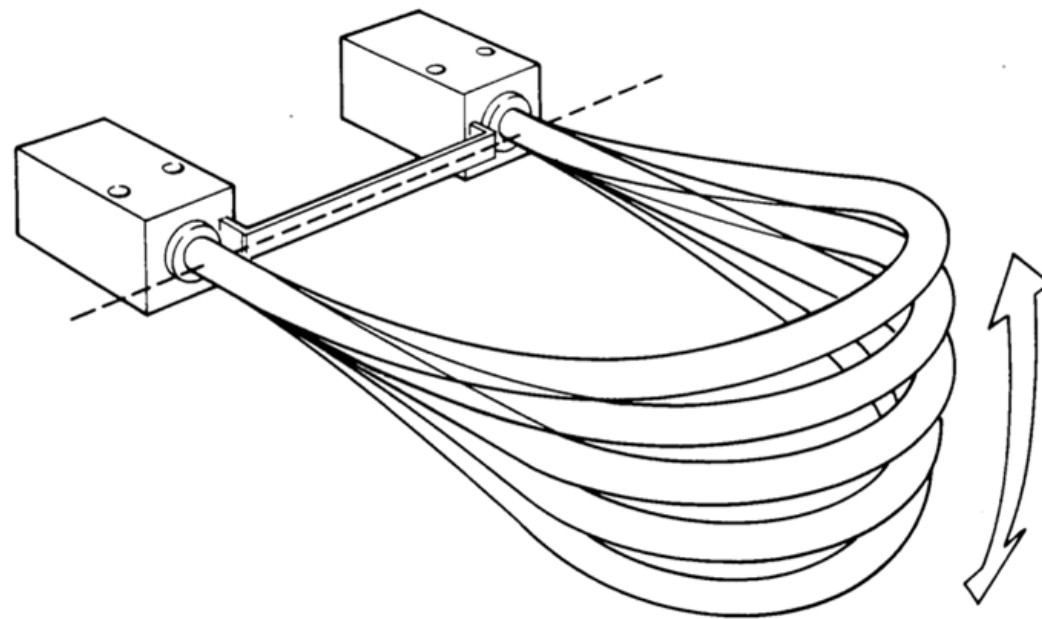
Introduction to Meter Verification

SMART Meter Verification (SMV) feature

SMV Basic versus Professional

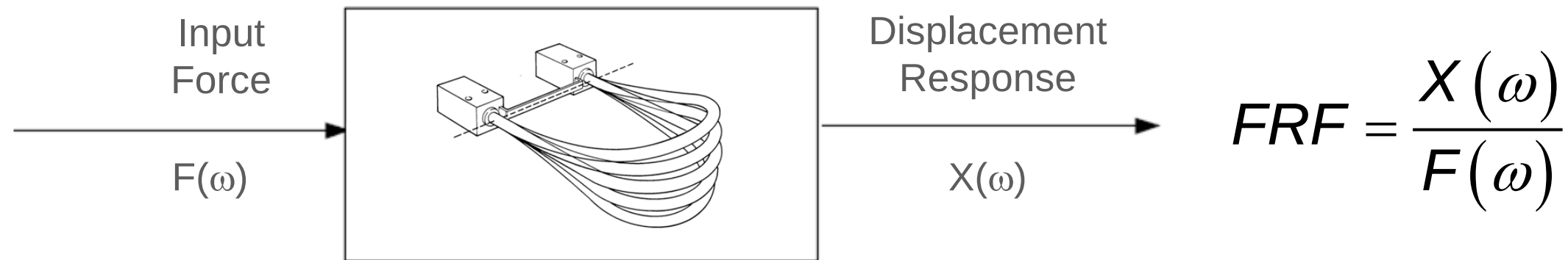
Analogy with a Coriolis sensor

- A Coriolis sensor behaves as an oscillating mass-spring system:
 - The *mass of the flow tubes* AND the *mass of the fluid* is the mass " m " of the system
 - The flow tubes have a stiffness " K "
 - The sensor is maintained in oscillation at its natural frequency " f_N "
 - The amplitude of deflection of the flow tubes is limited and maintained constant (the drive is amplitude-controlled)



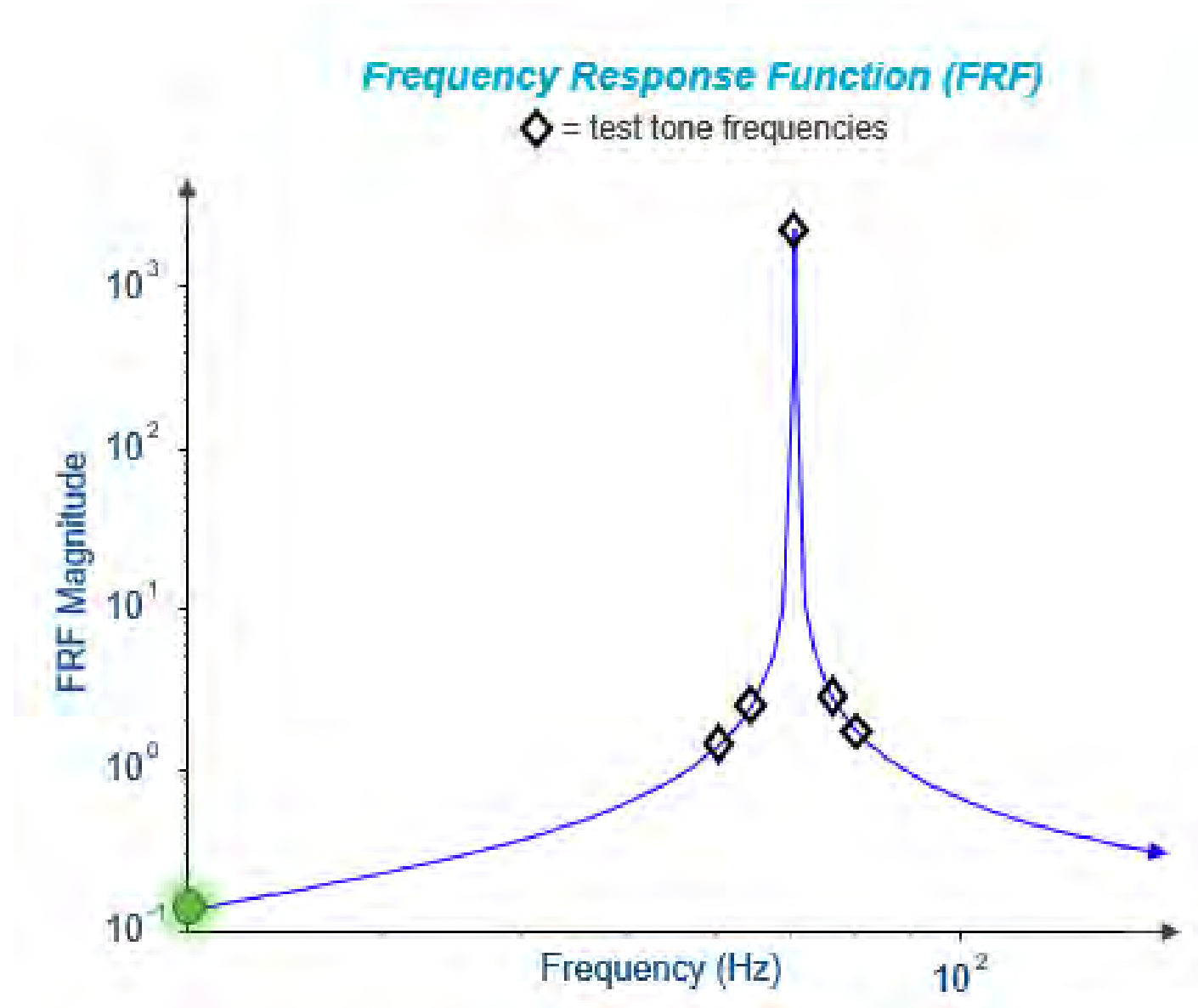
Frequency Response Function (FRF)

- The measurement of the structural integrity of the flow tubes is done by measuring the response of the tube to an applied force as a function of the frequency



- The analysis of the response to an input is given by the **F**requency **R**esponse **F**unction
- It represents the amplitude variations of the flow tubes resulting of an applied force over the frequency domain

Frequency Response Function $H(\omega)$



$$FRF = \frac{j\omega}{-m * \omega^2 + jC * \omega + K}$$

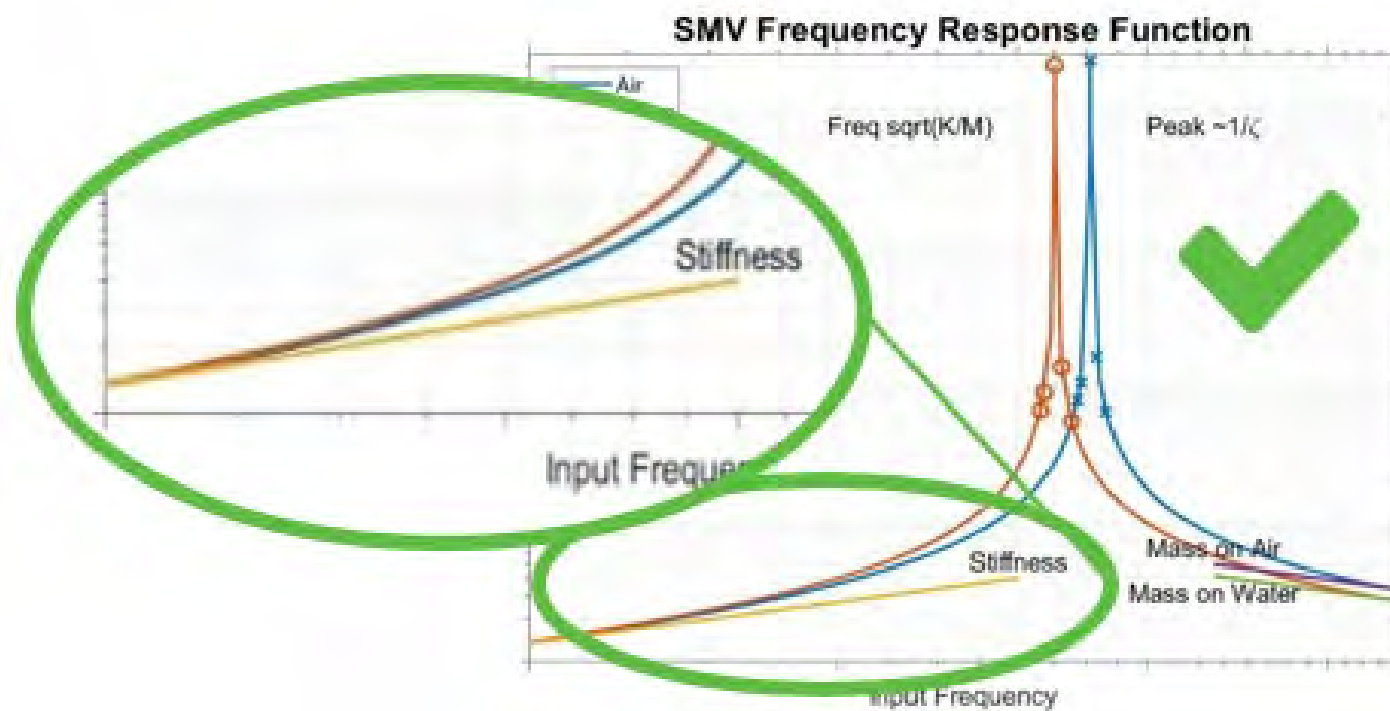
Analogy with a Coriolis sensor

- The Mass “**m**” is the mass of the fluid and of the flow tubes
 - The mass of the fluid depends on the Density (ρ)
- The Stiffness depends on the mechanical properties of the flow tubes
 - Material properties
 - Tubes diameter, wall thickness
 - Overall geometry (straight tube, U-shape tubes etc...)
- The Damping depends on the viscosity of the fluid (η)
 - The damping will be greater with a high viscous fluid than with a low viscous fluid (water, oil, honey)

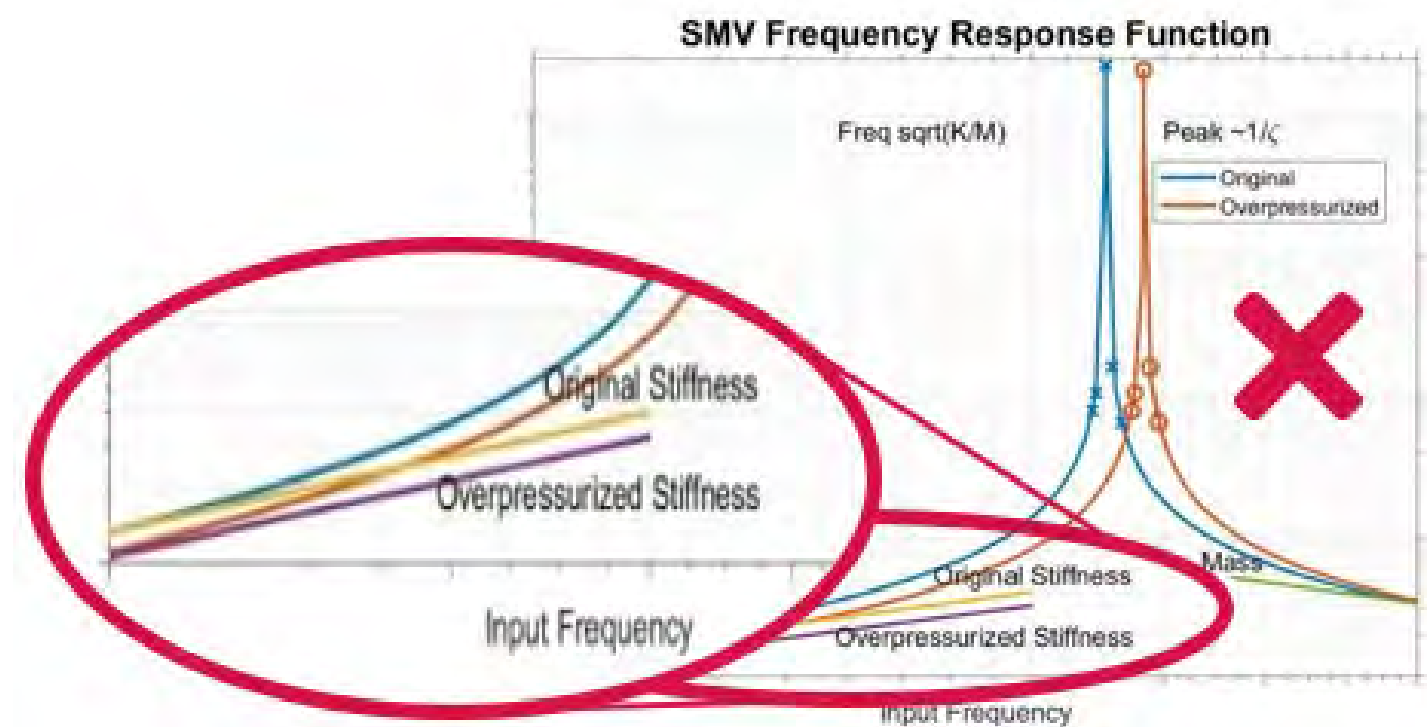
SMART Meter Verification

- The Meter Verification verifies the structural integrity of the sensor's flow tubes
 - The MV algorithms determine independently the **Mass**, the **Damping** and the **Stiffness** of the flow tubes,
 - The Stiffness issued from the verification is compared with the “factory” stiffness (saved during the calibration),
 - If the stiffness did not change over time, the density and flow calibration factors are unchanged,
 - The Meter Verification confirms the accurate density and flow measurement.

How can corroded tubes affect the FRF



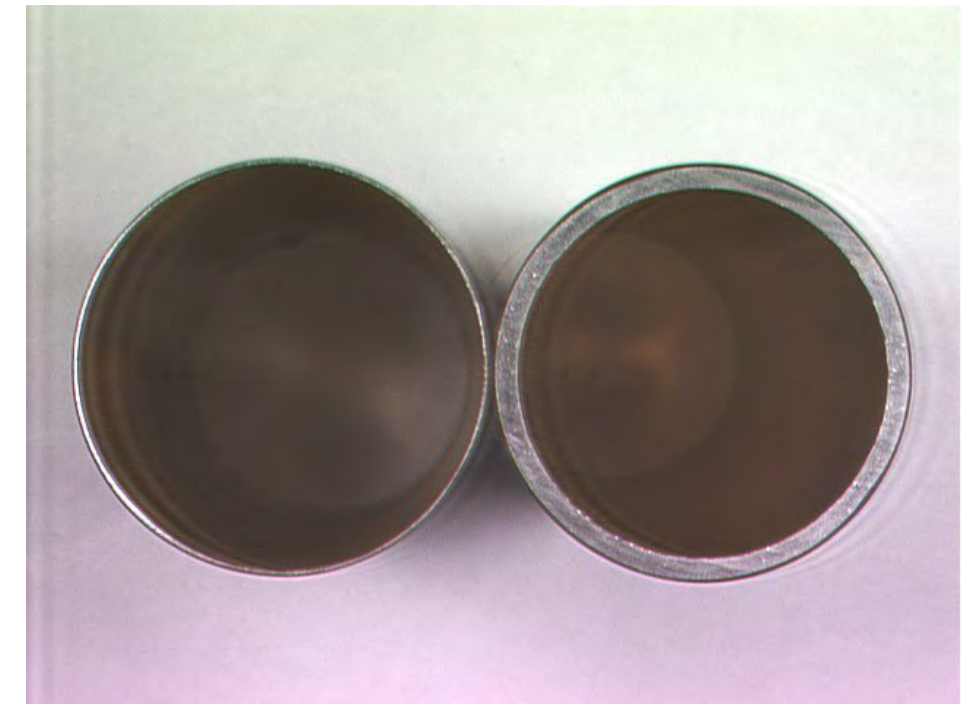
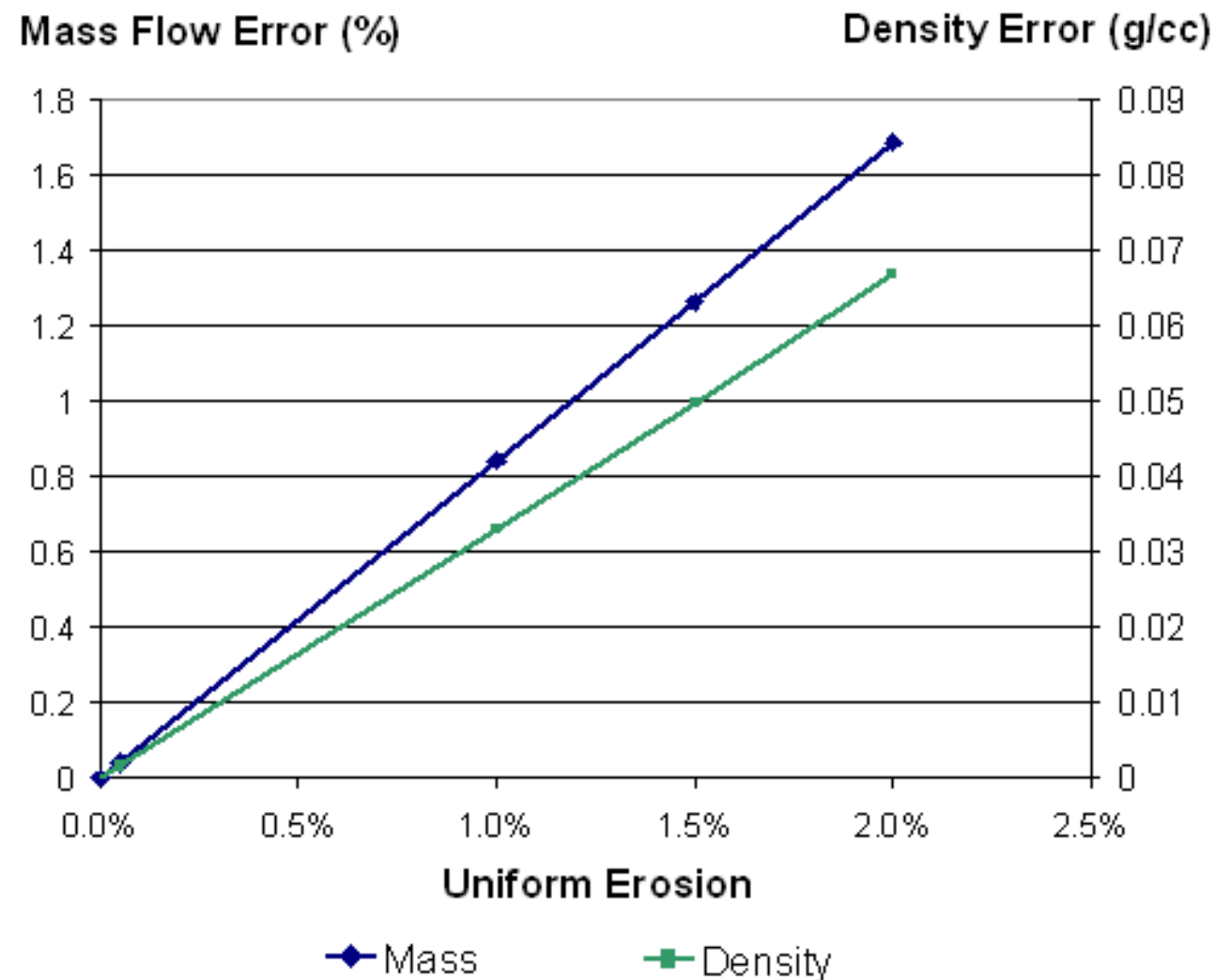
No stiffness change



Stiffness change

What can change the tube stiffness

- Uniform Corrosion (Cleaning in place)
- Uniform Erosion (abrasive slurries in fluid)

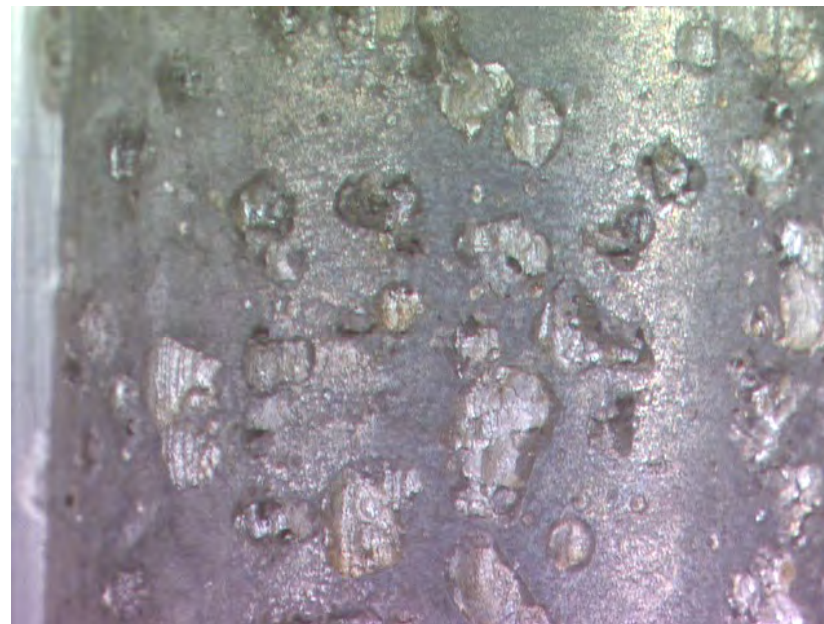


What can change the tube stiffness

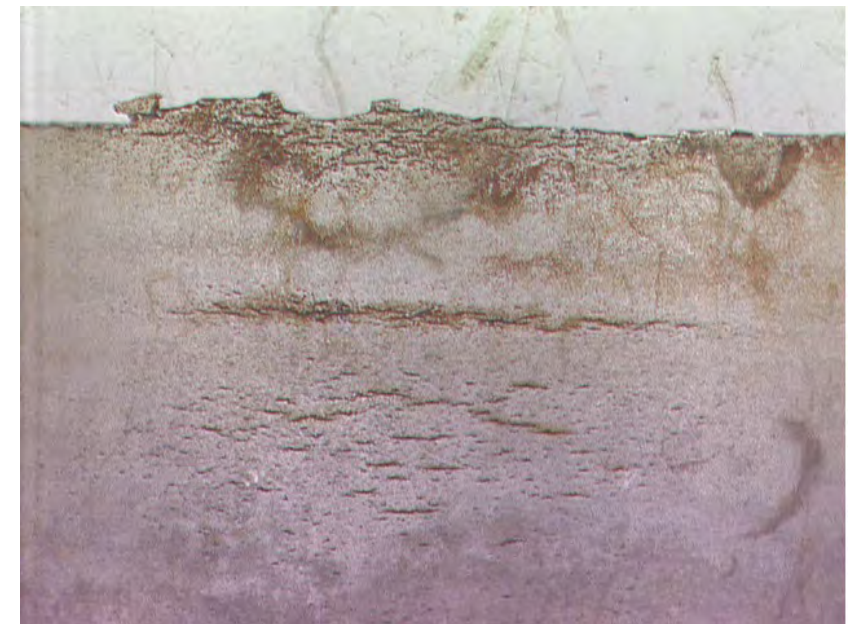
- Local Corrosion (Cleaning in place)
- Local Erosion
- Local damage (overpressure, stress)



Preferential Attack



Pitting Corrosion



Stress Corrosion

SMART Meter Verification



- During the Meter Verification routine, the algorithms determine the mass, damping and stiffness of the flow tubes



- The sensor is driven with test tones at different frequencies
- At each frequency, the deflection of the flow tubes is measured
- The FRF is determined
- The Stiffness is compared with the stored baseline

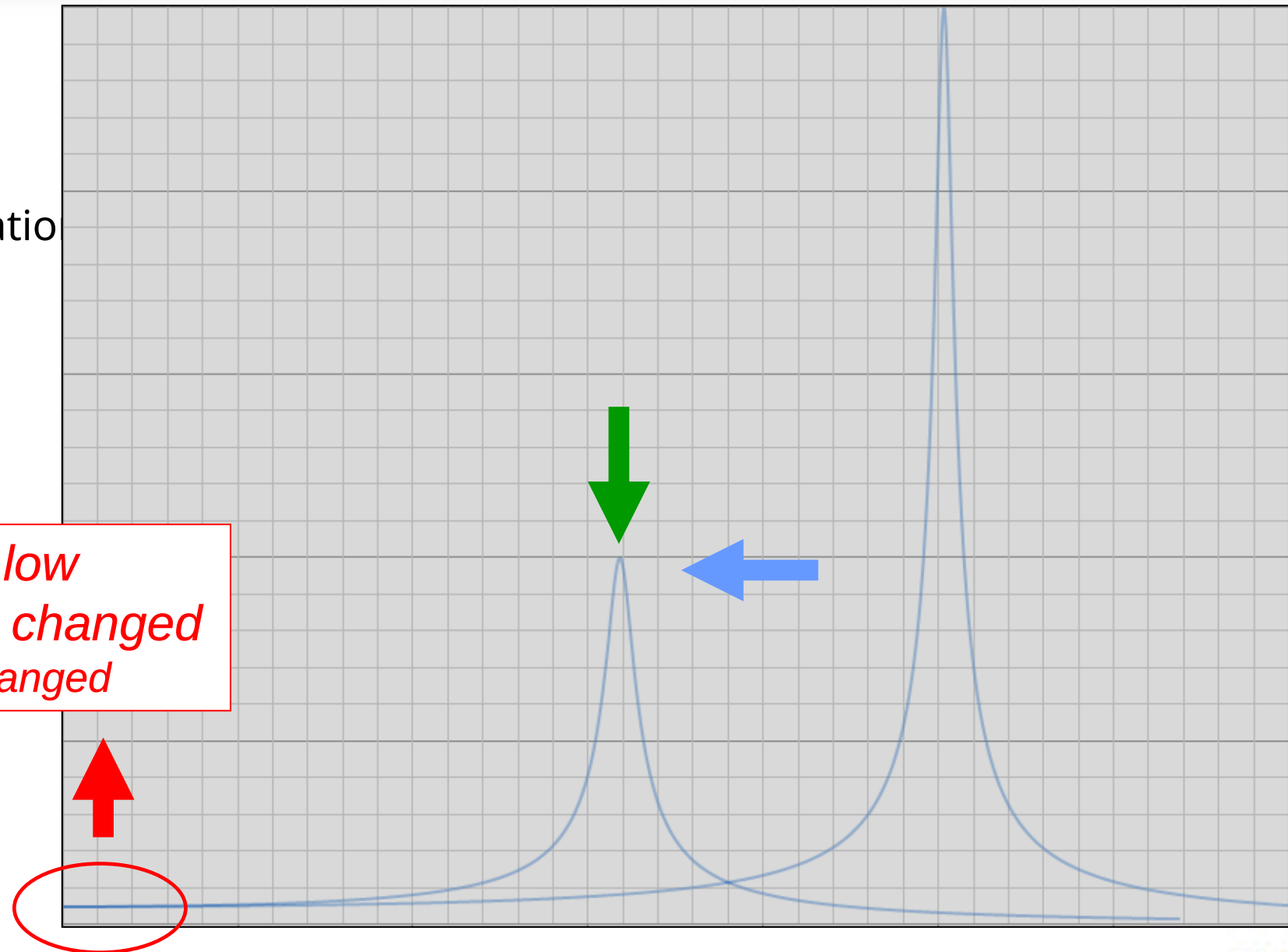
Effect of the Process Fluid during the SMV

- Why is the process fluid not important for the Meter Verification routine?
 - The Stiffness baseline has been saved in the factory based on air,
 - The Meter Verification routine is initiated in the field with a process fluid other than air.
- Example: The stiffness baseline has been saved in the factory based on Air and the Meter Verification is initiated with Oil as process fluid.
 - How will it impact the stiffness measurement?

Effect of the Process Fluid during the SMV

- With flow tubes filled with oil
 1. More mass in the tubes
 - Natural frequency $\downarrow$
 2. The oil tends to damp the oscillatio
 - Deflection $\downarrow$

*The magnitude at low frequency has not changed
 $\Rightarrow$ Stiffness K is unchanged*



Observation and Conclusion

- A fluid change will affect the Frequency Response Function
 - The Natural frequency will shift depending on the fluid Density
 - The fluid properties (Viscosity) will tend to damp the oscillations: the bandwidth of the FRF will increase with the viscosity
 - The magnitude at low frequency of the FRF (tube's Stiffness) remains unchanged
 - The fluid properties affect the Mass "**m**" and the Damping "**C**" but NOT the Stiffness "**K**"

The outcome of a Meter Verification routine is independent of the process fluid!

SMART Meter Verification feature



1. No Burden on Plant Operations
No interruption of process measurements.
Performed on demand when necessary or convenient.



2. Flexibility of Operation
Meter Verification can be initiated from the local display, ProLink, or AMS. Stiffness results for trend plotting are available from all interfaces.



3. Verification on Schedule
Scheduled operation will be possible either through the transmitter menus or through the AMS Snap-On, allowing for convenient regular verification procedures to be developed.



4. Event-Driven Verification
Automatically initiating Meter Verification based on events allows for peace of mind following potentially damaging process excursions.

SMART Meter Verification feature

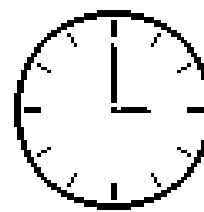
Manual Operation

- On Demand
- Less Than 2 Minutes



Scheduled Operation

- Automatic
- Every 1 to 1000 hours
- Associated with Alarms



Triggered Operation

- Process Events
- Discrete Input
- Associated with Alarms



SMART Meter Verification feature

Local Display



Handheld Communicator



ProLink

Smart Meter Verification - Start

Test Conditions

Test Name: Test 1

Note: Testing Smart Meter Verification

Sensor Operating Conditions

Mass Flow: 0.00000 mT on/hr

Volume Flow: 0.00000 m3/hr

Density: 0.00000 SGU

Temperature: 664.38458 °F

External Pressure: 0.00000 PSI

Configuration details with respect to previous report

Configuration Changed Details... Zero Unchanged Details...

NOTE: Device configuration changes have no impact on test results obtained using the Structural Integrity method of Meter Verification. These indicators appear here and are recorded in the database to verify the transmitter setup.

Meter Verification

Select Output Behavior

Continue Measuring

Outputs Held at Last Value

Outputs Held at Fault

Meter Verification will complete in 90 seconds. Outputs will be unaffected.

Start Meter Verification

Meter Verification Inactive

Meter Verification Run Counter

Meter Verification Inactive.

< Back Next > Cancel Help

AMS

Smart Meter Verification v2.0 - Start

Test Conditions

Test Name: Test 1

Note: Smart Meter Verification testing

Sensor Operating Conditions

Mass Flow: 0.00000 g/s

Volume Flow: 0.00000 L/s

Density: 9.95824 g/Cu cm

Temperature: 524.79712 degC

External Pressure: 0.00000 psi

Configuration Changes Since Previous Test

Configuration Unchanged Details... Zero Unchanged Details...

NOTE: Device configuration changes have no impact on test results obtained using the Structural Integrity method of meter verification. These indicators appear here and are recorded in the database to verify the transmitter setup.

Meter Verification

Select Output Behavior

Continue Measuring

Outputs Held at Last Measured Value

Outputs Held at Fault

Meter Verification will complete in 90 seconds. Outputs will be unaffected.

Start Meter Verification

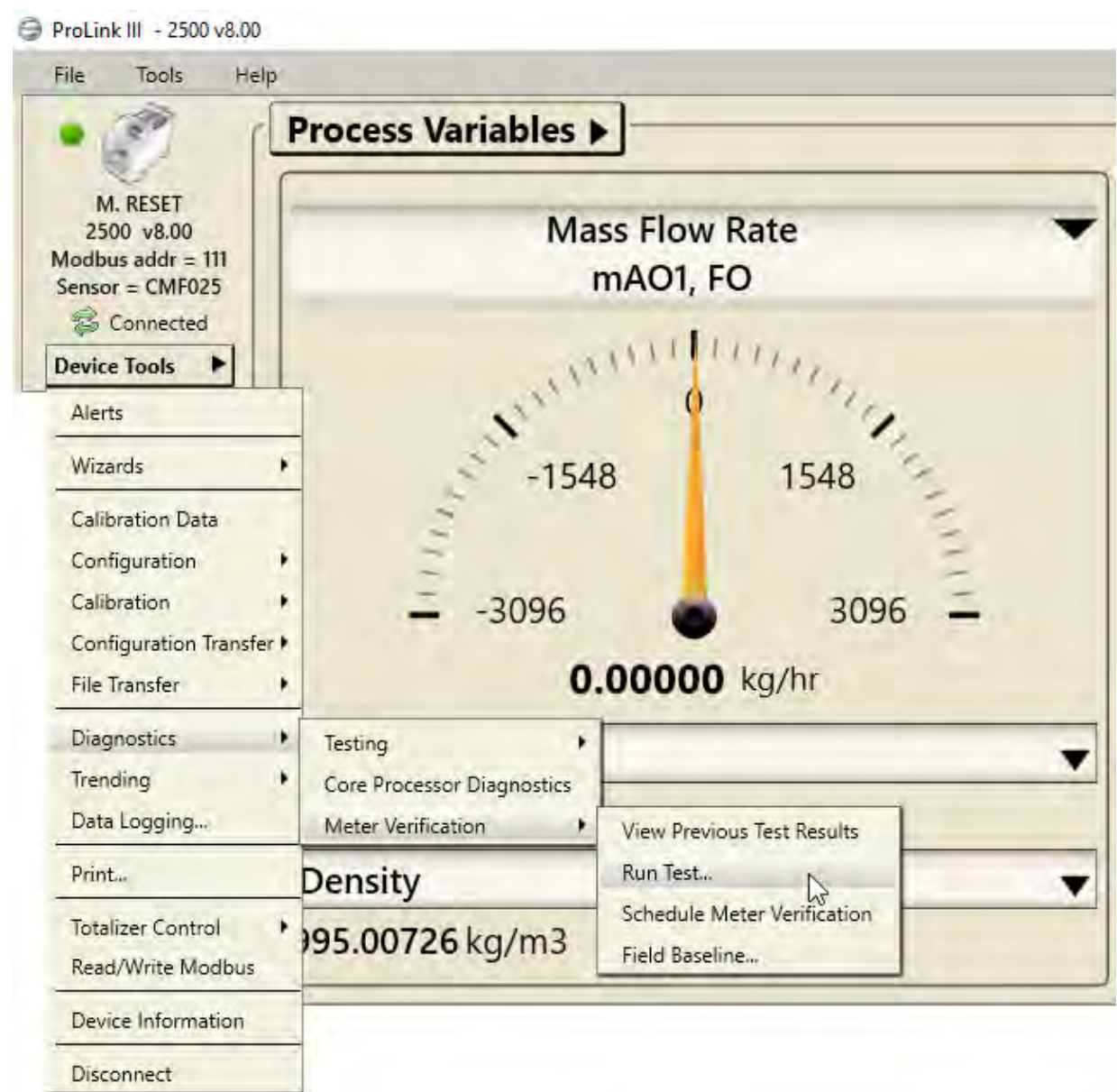
Meter Verification Inactive

Meter Verification Run Counter

Meter Verification Inactive.

< Back Next > Cancel Help

SMART Meter Verification feature



The 'Smart Meter Verification Test Definition' dialog box is shown. It contains three main sections: Sensor Identification, Customer Identification, and Test Definition. The Sensor Identification section includes fields for Sensor Serial Number (14072677) and Sensor Model (CMF025), with a 'View Previous Test Results' button. The Customer Identification section includes fields for Instrument Owner (Production Line 3), Company (Goodhead Inc.), Location (Biesheim (57)), Contact Name / Tested By, Telephone, and Application/Service. The Test Definition section includes a Test Name field (Start-up) and a Notes field. At the bottom right, there are '< Back', 'Next >', and 'Cancel' buttons.

SMART Meter Verification feature

Smart Meter Verification Start

Configuration Details with respect to Previous Report

☒ Configuration Unchanged

Details

☒ Zero Unchanged

Details

Note: Changes to device configuration have no impact on test results obtained using the structural integrity method of Smart Meter Verification. These indicators appear here and are recorded in the database only to verify the transmitter setup.

Select Output Behavior

☒ Continue Measuring

☐ Held at Last Value

☐ Held at Fault

☒ Meter Verification will complete in 90 seconds. Outputs will be unaffected.

Sensor Operating Condition

Mass Flow Rate

0.00000

kg/hr

Volume Flow Rate

0.00000

l/hr

Density

997.81610

kg/m3

Temperature

Meter Verification

Meter PASSED Verification, Meter meets factory specifications.

OK

Abort

15 %

3

Initializing Notch Filters

Meter Verification Run Counter

!

Meter Verification in Progress.

< Back

Next >

Cancel

Smart Meter Verification Result

Transmitter Model: 5700 Configurable I/O, Transmitter Serial Number: 12111329, Sensor Model: RFH/025

Sensor Serial Number: 14387970, Core Processor Serial Number: 10023402

Run Number	Date/Time	Result	Reason
39	6/24/2020 12:34:27 PM	Pass	Meter is unchanged
38	12/5/2019 10:01:05 AM	Abort	Drive frequency drift from carrier frequency
37	12/5/2019 11:23:17 AM	Pass	Meter is unchanged
36	12/5/2019 10:18:53 AM	Pass	Meter is unchanged
35	12/5/2019 10:15:43 AM	Pass	Meter is unchanged
34	12/5/2019 9:51:02 AM	Pass	Meter is unchanged
33	12/4/2019 4:01:16 PM	Pass	Meter is unchanged
32	12/4/2019 2:41:42 PM	Pass	Meter is unchanged
31	12/4/2019 2:12:22 PM	Pass	Meter is unchanged
30	12/4/2019 1:09:42 PM	Pass	Meter is unchanged
29	12/4/2019 12:49:32 PM	Pass	Meter is unchanged
28	12/4/2019 12:23:02 PM	Pass	Meter is unchanged
27	12/4/2019 11:25:58 AM	Pass	Meter is unchanged
26	12/4/2019 11:19:53 AM	Fail	Possible coating or corrosion/erosion
25	12/4/2019 11:17:18 AM	Fail	Possible coating or damage
24	12/3/2019 4:58:31 PM	Pass	Meter is unchanged
23	12/3/2019 4:55:51 PM	Pass	Meter is unchanged
22	12/3/2019 4:53:36 PM	Fail	Possible damage
21	12/3/2019 1:46:25 PM	Pass	Meter is unchanged

Export Data to CSV File

< Back

Next >

Cancel

Reporting

Smart Meter Verification Report

View previous test report...

1 of 3 Page Width

EMERSON **Coriolis Smart Meter Verification** **MICRO MOTION**

woensdag 24 juni 2020
12:34:27

Pass - No Damage or Coating Detected
Meter is Performing Within Factory Specifications

Details	Status
Sensor	Pass
Transmitter/Electronics	Pass
User-Configured Critical Alarms	Pass
Maintenance Alarms	Pass
Other Alarms	Pass
SD Card Status	Pass
Multiphase Severity	Pass
Flow Range	Pass
Configuration Changed	No
Zero Changed	No

Instrument Owner : Instrumentation dept Contact Name/Tested By : Peter Bigbreast

Note: Right-click on the report to print or export. Report and SMVData is saved in the following path,
C:\Program Files (x86)\MMI\ProLink III\MeterVerification\FT-100-14387970-39
[Click to open saved report and SMV Data](#)

Export Data to CSV File Save and Print Report < Back Finish Cancel

Smart Meter Verification Report

View previous test report...

1 of 3 Page Width

Instrument Owner : Instrumentation dept Contact Name/Tested By : Peter Bigbreast
Company : Sweetwater and Co Telephone : +31 651986543
Location : Ede Application/Service : Mineral Oil
Note : Run Counter : 39

Meter Information

Transmitter Tag : FT-100 Sensor Model : RFH/025
Transmitter Model : 5700 Configurable I/O Sensor Serial Number : 14387970
Transmitter Serial Number : 12111329 Core Processor Unique ID : 3238096
Core Processor Serial Number : 10023402

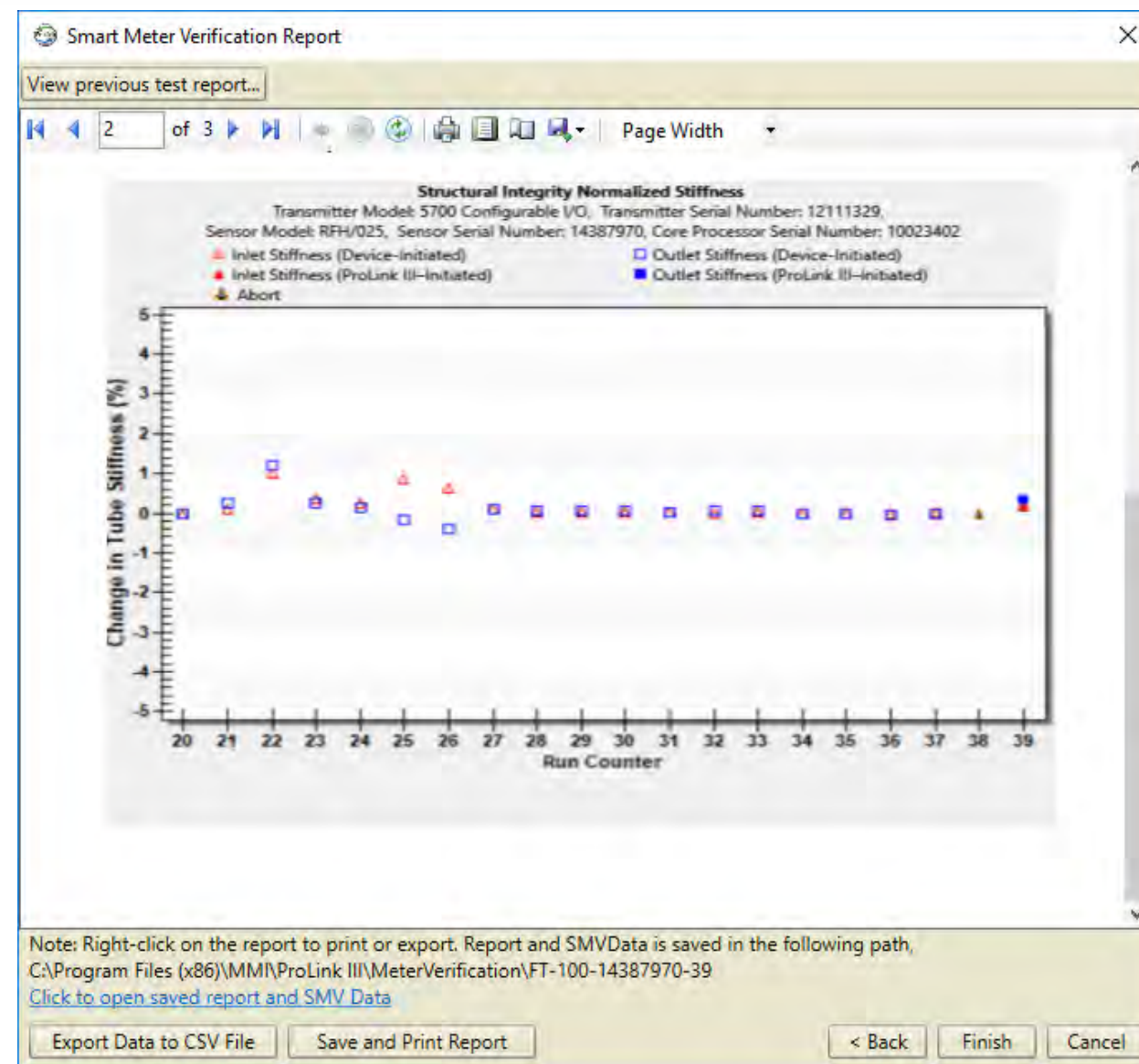
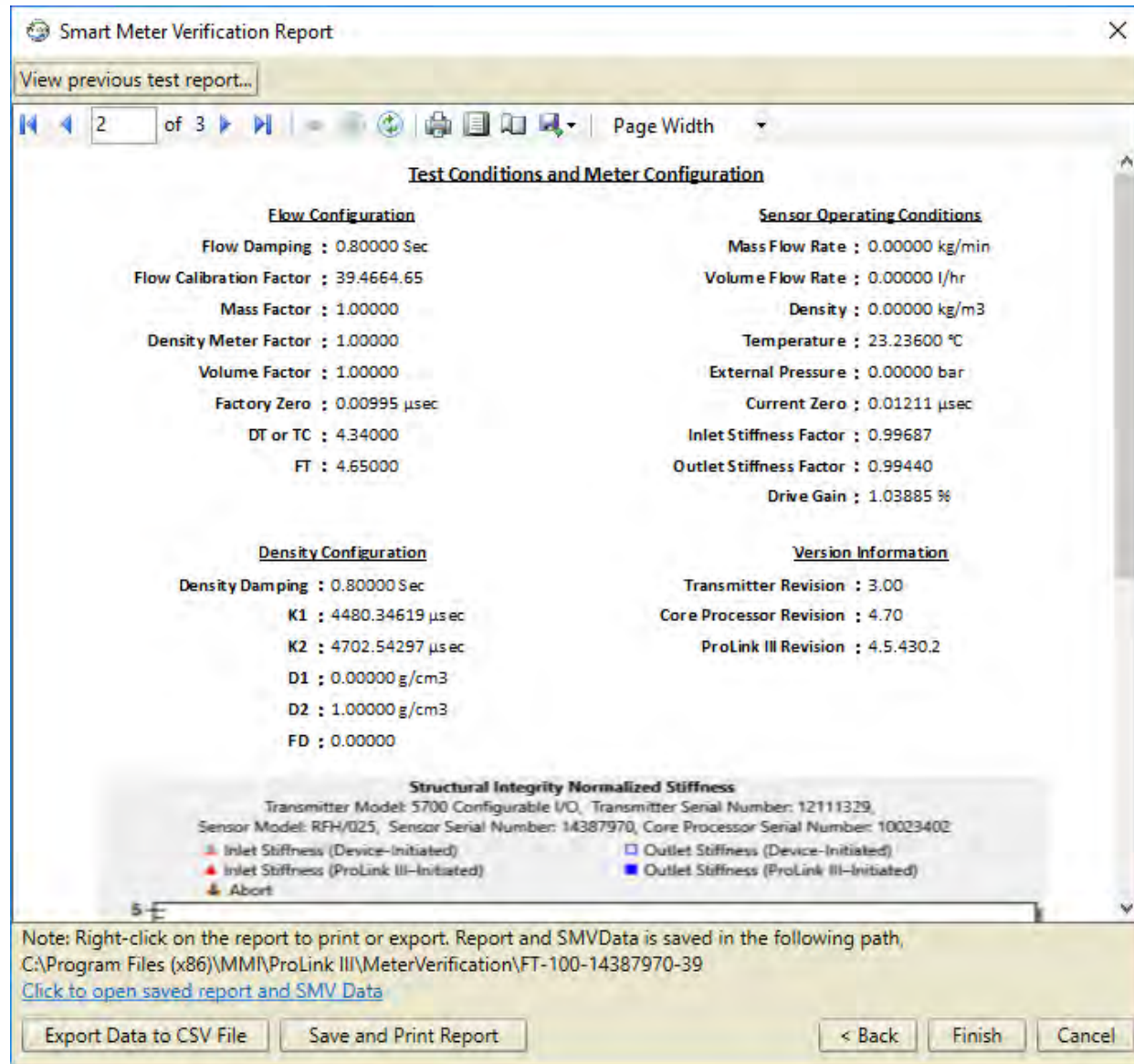
Customer Signature: _____

NOTE: All meters are factory calibrated in NIST-traceable labs certified to ISO-17025 and 9001. Smart Meter Verification complies with recommendations/standards from numerous global organizations such as ISO, Exida (IEC), AGA-11, API MPMS Ch 14.9, USA EPA, and API Q1, 9th edition.

Note: Right-click on the report to print or export. Report and SMVData is saved in the following path,
C:\Program Files (x86)\MMI\ProLink III\MeterVerification\FT-100-14387970-39
[Click to open saved report and SMV Data](#)

Export Data to CSV File Save and Print Report < Back Finish Cancel

Reporting



Reporting

Smart Meter Verification Report

View previous test report...

3 of 3 Page Width

Previous Test Results

Run Number	Date/Time	Result	Reason
39	6/24/2020 12:34:27 PM	Pass	Meter is unchanged
38	12/5/2019 10:01:05 AM	Abort	Drive frequency drift from carrier frequency
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35	12/5/2019 10:15:43 AM	Pass	Meter is unchanged
34	12/5/2019 9:51:02 AM	Pass	Meter is unchanged
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32	12/4/2019 2:41:42 PM	Pass	Meter is unchanged
31	12/4/2019 2:12:22 PM	Pass	Meter is unchanged
30	12/4/2019 1:09:42 PM	Pass	Meter is unchanged

BACKGROUND

A Coriolis meter has no moving parts and there is nothing to wear or break. Therefore, in a clean fluid, the expectation is that the meter will not exhibit a calibration change over time.

Fluids that corrode, erode, or coat the flow tube can alter the mechanical characteristics of the meter and may change the meter's calibration. Other mechanical damage (such as over pressurization) can also affect the meter's calibration. Smart Meter Verification measures the mechanical characteristics of the meter and detects subtle changes that affect the calibration constants.

METHOD

Note: Right-click on the report to print or export. Report and SMVData is saved in the following path, C:\Program Files (x86)\MMI\ProLink III\MeterVerification\FT-100-14387970-39
[Click to open saved report and SMV Data](#)

Export Data to CSV File Save and Print Report < Back Finish Cancel

Smart Meter Verification Report

View previous test report...

3 of 3 Page Width

METHOD

Smart Meter Verification compares the mechanical properties of the meter at operating conditions to the factory measured values. Smart Meter Verification is independent of the process fluid in the meter. During meter commissioning, Micro Motion recommends performing Smart Meter Verification as part of the installation procedure. Micro Motion recommends running Smart Meter Verification periodically (at least once per month) using the scheduling feature in the transmitter.

ACTION

When the Smart Meter Verification test is completed, the result is reported as Pass, Fail, or Abort.

Pass Smart Meter Verification does a statistical check between the factory base line value and the current Smart Meter Verification result. Pass indicates that the two values are statistically the same.

Fail The current SMV value is statistically different from the factory base line value. If a fail result is obtained, SMV should be performed a second time.

- If the meter passes a second test, the first result can be ignored.
- If the meter fails the second test, the flow tubes may be damaged or coated. Use your process knowledge to determine the possibilities for damage and the appropriate actions for each. These actions might include cleaning the meter, or removing the meter from service and physically inspecting the tubes. At a minimum, you should perform a flow validation and density calibration.

Abort A problem occurred with the meter verification test (e.g., process instability) or you stopped the test manually. See the flow meter user manual for a list of abort codes, a description of each code, and possible actions you can take in response.

Note: Right-click on the report to print or export. Report and SMVData is saved in the following path, C:\Program Files (x86)\MMI\ProLink III\MeterVerification\FT-100-14387970-39
[Click to open saved report and SMV Data](#)

Export Data to CSV File Save and Print Report < Back Finish Cancel

Agenda

Introduction to Meter Verification

SMART Meter Verification (SMV) feature

SMV Basic versus Professional

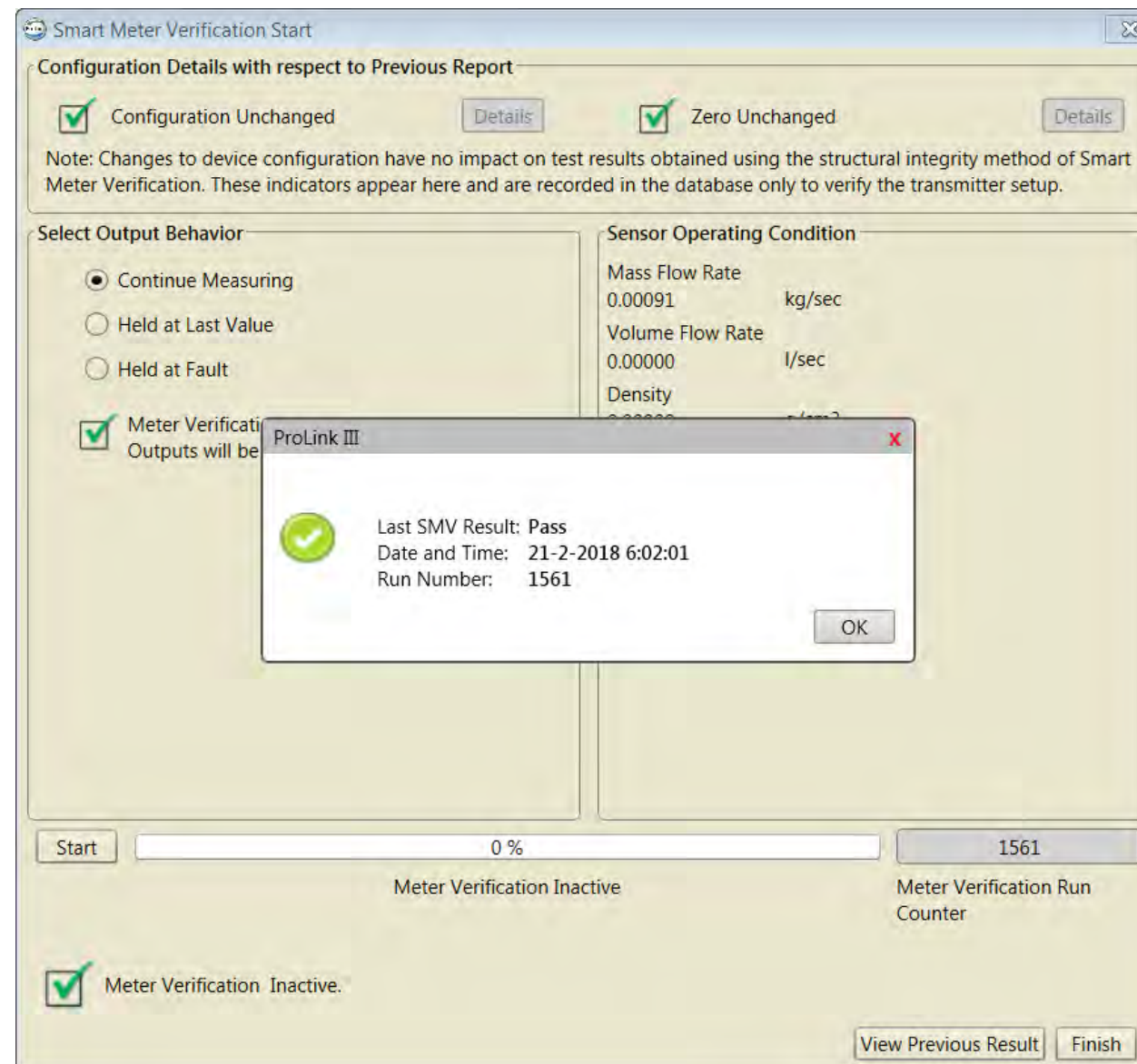
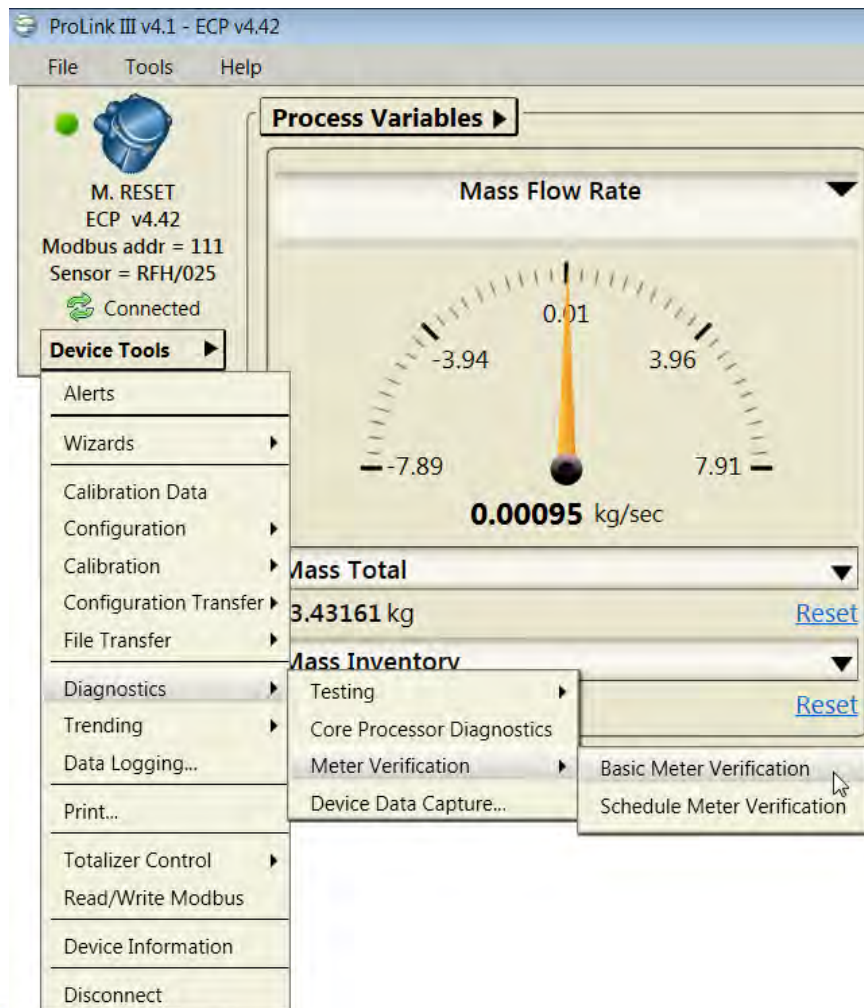
SMV Basic versus Professional

- All new transmitters combined with an 800-core processor include SMV Basic (free of charge) and, for the 5700 only, a 90-day Trial of SMV Professional (free of charge)

	Basic	Professional	
Sensors	CMF, CMFS, F and H		
Transmitters	Direct Connect, 1500, 1700, 2400, 2500, 2700, 5700	Direct Connect, 1500, 1700, 2400, 2500, 2700, 5700	5700
Access	Included	Licensed	90-Day Trial, Licensed
Calibration verification	●	●	●
Electronics verification	●	●	●
Automation	●	●	●
Compliance Report		●	●
Previous 20 verifications stored		●	●
Installation verification			●
Multiphase diagnostic			●
Flow range diagnostic			●

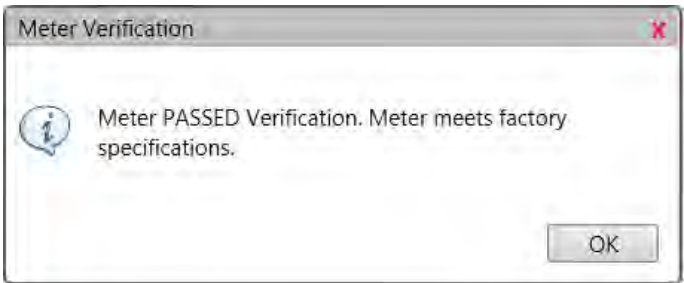
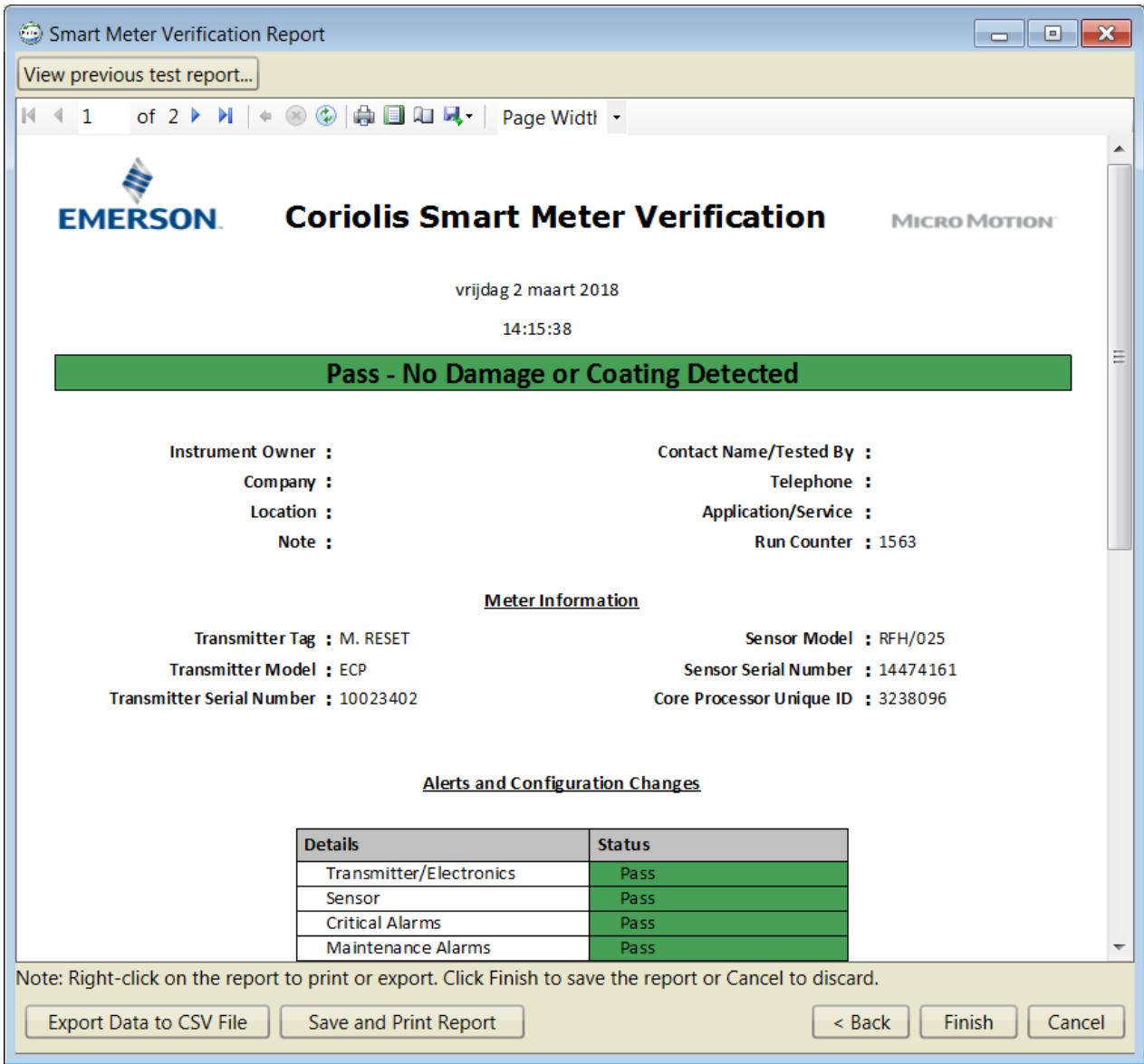
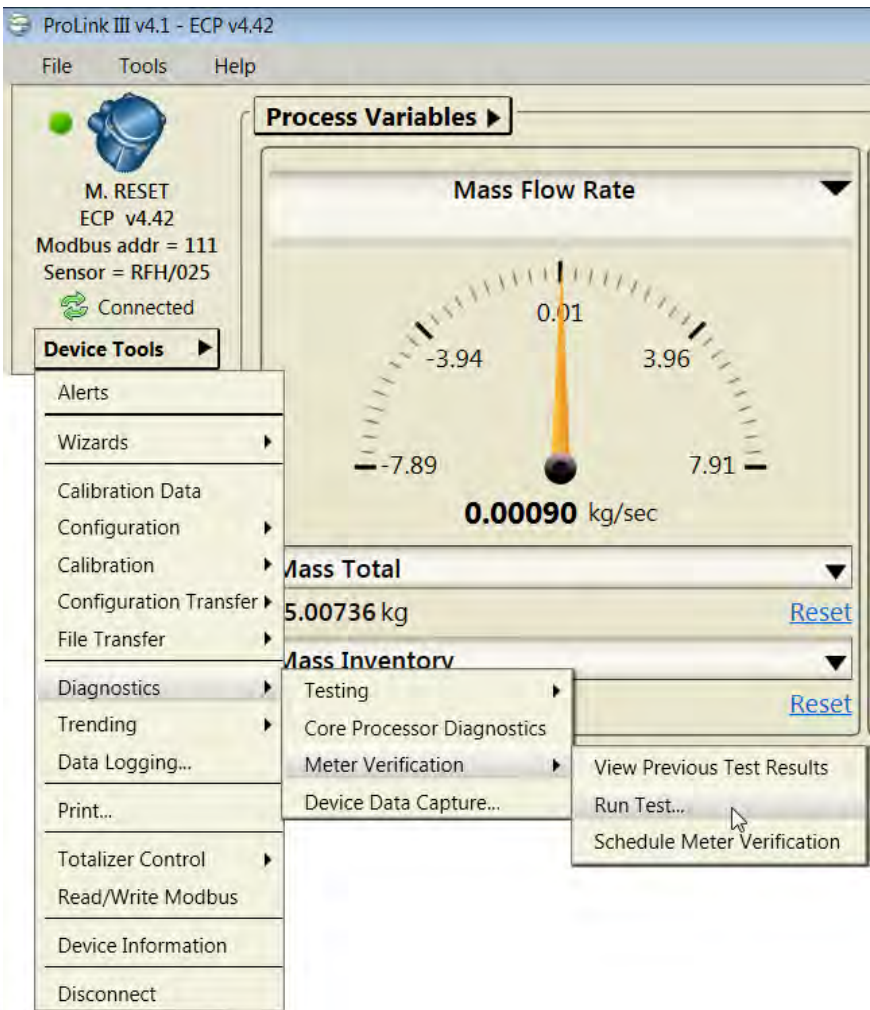
SMV Basic

- Only Last SMV result visible
- Only Pass/Fail message
- No SMV report



SMV Professional

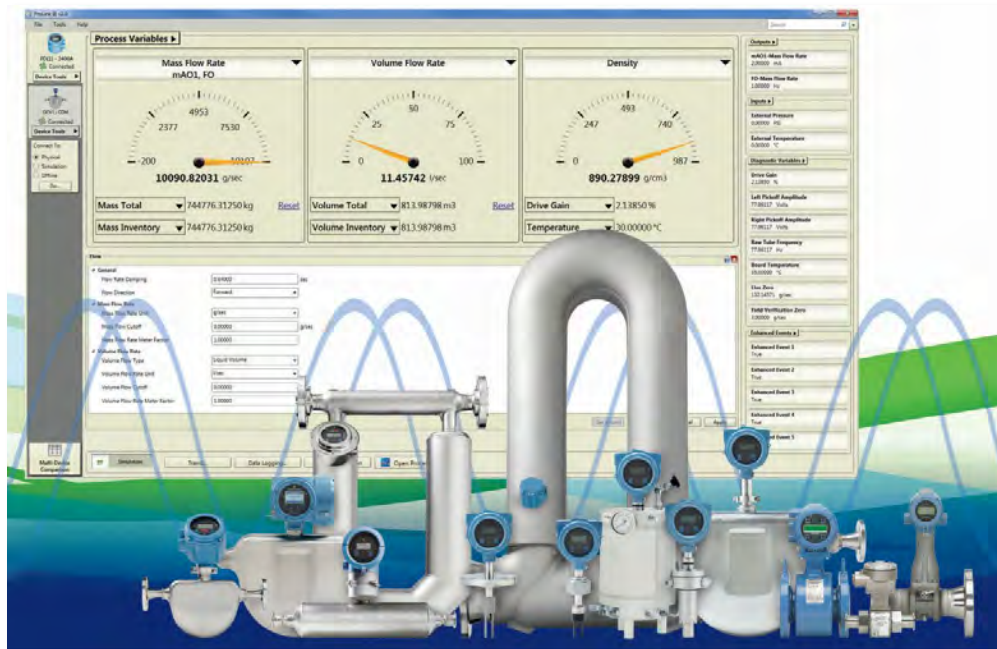
- Full functionality
- SMV report
- Historical data



- Advanced diagnostics: SMART Meter Verification
 - Diagnosis of the whole system
 - Whenever you want
 - On schedule
 - No Measurement Interruption
 - Helps to evaluate the proving intervals or re-calibration frequency

Diagnostics

Recap



Smart Meter Verification Report

View previous test report...

1 of 3 Page Width

EMERSON Coriolis Smart Meter Verification **MICRO MOTION**

Monday, May 11, 2020
9:12:20 PM

Pass - No Damage or Coating Detected

Details	Status
Sensor	Pass
Transmitter/Electronics	Pass
User-Configured Critical Alarms	Pass
Maintenance Alarms	Pass
Other Alarms	Pass
SD Card Status	Pass
Multiphase Severity	Pass
Flow Range	Pass
Configuration Changed	No
Zero Changed	No



Questions

