Best Practices for Coriolis Meter Proving

This quick reference guide details Coriolis proving best practices. This is based on over 30 years of direct field experience in proving Coriolis custody transfer measurement systems.

Meter Sizing

When sizing a Coriolis meter for proving applications, ensure the following:

1) The flow range over which the meter will operate and be proved, does not exceed a flowing velocity of 60 ft/sec through the meter.
2) The optimum flow signal stability for proving is obtained with flow velocities of 3 to 60 ft/sec. Over wider turndowns, it may be necessary to utilize a different meter factor for lower rates.
3) In general, the following are the minimum recommended flow rates with 0.8 specific gravity fluid:

2”	50 BPH
3”	100 BPH
4”	600 BPH

6”	800 BPH
8”	1600 BPH
10”	1800 BPH

Software Requirements

To achieve the optimum response and update times for proving the following software levels are required.

Transmitter Model	2700	2700	2400	FMT
Transmitter S/W Rev	All	Rev 5.XX +	Rev 1.43 +	All
Core Processor	700	800	800	800
Core S/W Rev	All	Rev 3.44 +	All	All
Response Time	100-110 ms	50-60 ms	50-60 ms	50-60 ms
Update Time	10 ms	10ms	10 ms	10 ms

Table 1. Electronics Software Requirements

The Coriolis Meter Configuration

For proving ease, configure the meter to operate in its fast response and high repeatability mode, utilizing the following configuration settings:

1) Update rate is set to “special”
2) Response time is set to “special” (Model 800 Core Only)
3) Flow damping is set to a value of 0.0
4) Select, either “mass” or “volume” flow for the 100 Hz proving variable
5) Set the frequency output, “pulses per a unit” value to as high a value as possible
6) Density damping is set to a value of 0.16 seconds

Note: When setting the “pulse per unit” value, insure its setting does not cause the frequency output “frequency factor” in hertz to exceed the transmitter’s maximum output frequency of 10,000 Hz, and the maximum input frequency of the Prover Counter or Flow Computer.

Site & Equipment Considerations

It is important to consider all factors that can affect a proving, including:

1) Verification of calibrations on all references should be conducted; i.e. temperature, pressure, density, and volume.
2) Flow pulsations from positive displacement pumps will affect proving repeatability.
3) The meter should be proved under the same conditions as it is normally expected to operate.
4) Flow conditions must be stable during the proving run to achieve repeatable results. The following flow conditions must be stable from the inlet of the meter under test to the outlet of the prover.
   a. Temperature
   b. Pressure
   c. Density
   d. Flow Rate
5) In applications where pressure varies, lack of Coriolis pressure effect compensation may cause repeatability and reproducibility issues.
6) For inferred mass proving, a prover density measurement error will cause meter factor error. A pycnometer or hydrometer should be used to verify and apply a density meter factor, if necessary, to the indicated density. When utilizing a pycnometer, the following tolerances should be met:
   a. Temperature difference should not exceed 0.2°F
   b. Pressure difference should not exceed 1 psi
   c. Density Meter Factor (DMF) repeatability should be 0.05% or better between two consecutive pycnometer tests/measurements
7) Valve leakage in the system can result in a false meter zero or allow flow to bypass the prover. Double block and bleed isolation valves are recommended for leak testing purposes.
8) The certified measurement section and detector switches of the prover must be verified to be undamaged and in good working condition.
9) Note that the higher the flow rate the shorter the run time; therefore, Coriolis meters may require a larger small volume prover (SVP) than traditional mechanical meters. For estimation purposes only, deduct 33% from the maximum rate on a small volume prover (SVP) sizing chart.
10) Insure there is adequate back pressure on the meter under test and the flow prover to avoid vapor breakout. The following equation shall be utilized to determine back pressure.

Equation: $\rho_b = 2\Delta\rho + 1.25\rho_e$

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Where: ρ_b = Minimum back pressure

$\Delta\rho$ = Pressure drop across meter at max. flow rate (gauge)

ρ_e = Equilibrium vapor pressure of the fluid at operating temperature (absolute)

Meter Zero

A good meter zero will produce a meter factor closer to 1.0000. The effects of meter zero on meter factor are particularly relevant at low flow rates.

1) It is recommended that the meter be zeroed when it is first commissioned
2) The zero verification tool should always be used to determine if re-zeroing is necessary. There is no need to re-zero if the meter's zero is within tolerance.
3) There is no need to re-zero if the meter's meter factor remains within tolerance.
4) If a meter is re-zeroed, a new proving meter factor should be obtained

Master Meter Proving

A master meter proving will produce better repeatability because the prove run-time can be as long as desired, or chosen by the batch size rather than defined by the size/volume of the prover. Being a transferable reference method, master meter proving is considered to have a higher uncertainty than direct volume or gravimetric proving.

Number of Proving Runs and Repeatability

"Validity of the average meter factor to a random uncertainty of 0.00027", is the API requirement for proving. The repeatability requirement decreases as the number of runs in a prove increases. Table 2 shows the API MPMS 4.8 requirement:

API MPMS Ch. 4.8 Runs at proving repeatability to meet ±0.027% uncertainty of meter factor		
Number of Runs	Repeatability	Uncertainty
3	0.02%	±0.027%
4	0.03%	±0.027%
5	0.05%	±0.027%
6	0.06%	±0.027%
7	0.08%	±0.027%
8	0.09%	±0.027%
9	0.10%	±0.027%
10	0.12%	±0.027%
11	0.13%	±0.027%
12	0.14%	±0.027%
13	0.15%	±0.027%
14	0.16%	±0.027%
15	0.17%	±0.027%
16	0.18%	±0.027%
17	0.19%	±0.027%
18	0.20%	±0.027%
19	0.21%	±0.027%
20	0.22%	±0.027%

Table 2. API MPMS 4.8 Repeatability Requirement

Sets of runs can also be averaged for the repeatability calculation. One technique is the averaging of three sets of five proving runs. An example of this technique is as follows:

Proving Run Set #1 — 30005, 30009, 30003, 30007, 30001
Repeatability = 0.03

Proving Run Set #2 — 29996, 30002, 30006, 30004, 29998
Repeatability = 0.03

Proving Run Set #3 — 29995, 30001, 30008, 29998, 30005
Repeatability = 0.04

Average of first set is: 30005
Average of second set is: 30001
Average of third set is: 30001

Repeatability = (max – min) / min = 0.01%

Averaging allows for more flow fluctuations during proving, the more data that is averaged, typically the better the repeatability.

Need More Information?

Micro Motion has extensive field experience in mass and volume proving of our Coriolis meters. Contact us at 1-800-522-6277 or visit our website at www.MicroMotion.com

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