# FLUENTA CALIBRATION

## IMPROVING ACCURACY AND REDUCING UNCERTAINTY IN OPERATIONS

### A RIGOROUS APPROACH

Calibration is a crucial step in ensuring the accuracy, reliability, and operational readiness of Fluenta's ultrasonic flare gas meters. We offer both 'wet' and 'dry' calibration methods. Wet calibration involves testing  flowmeters (transducers to be accurate) with air flowing under controlled conditions to ensure accurate measurements in real-world scenarios. Dry calibration, on the other hand, simulates flow conditions electronically without physical fluids, verifying instrument accuracy through electronic signals and software-based tests.

This document details the various processes we offer, explores the rationale behind using a 12" line and air for testing, describes available configuration options, and demonstrates why this setup provides representative results transferable to actual process conditions.

We offer a range of options, some of which, like the primary calibration, are undertaken as standard on all systems we produce. Our more advanced calibrations are options wherever a higher level of accuracy is required, or where certain regulatory regimens require it.

### SERVICES OFFERED

Fluenta offers a range of calibration services to ensure the accuracy and reliability of its ultrasonic flare gas meters.


1. Primary calibration is a mandatory dry calibration performed at the factory, where each transducer undergoes resonance frequency testing, impedance checks, delay time analysis, and velocity of sound verification. This ensures an accuracy level between 2.50-5.00% in accordance with AGA8 calculations.

2. Our in-house 'flow calibration' is an optional wet calibration carried out in our controlled laboratory setting to meet stricter accuracy requirements. During this process, flowmeters are tested at five different velocities using a reference meter, achieving accuracy levels of up to 1.00% for single-path meters and 0.75% for dual-path meters.

3. We also offer third-party calibration services in external test laboratories when specifically required by customers. These calibrations are conducted at internationally recognized facilities such as Force Technology, VSL, and CEESI, ensuring compliance with the highest industry standards. External laboratory calibration provides additional verification of meter accuracy under controlled conditions, often using customer-specified test parameters and flow conditions. This service is particularly valuable for projects requiring independent certification or adherence to stringent regulatory requirements.

4. Site zero calibration is a mandatory step performed on-site before commissioning to confirm that transportation has not affected sensor performance. A Fluenta-certified engineer conducts this check using a zero box to verify that the transducers remain within factory specifications.

5. Yearly zero calibration is recommended as part of routine maintenance to ensure continued sensor accuracy and reliability. Conducted annually by Fluenta-trained engineers, this process helps maintain optimal performance despite environmental and operational conditions.

6. In addition to the above, Flow re-calibration is an optional wet calibration service that allows transducers to be re-tested after a period of use. While this process requires retrieving the transducers, it does not involve removing mechanical components such as valves or spool pieces. The re-calibration includes a detailed factory assessment and flow testing to verify continued accuracy.

## CALIBRATION PROCESS OVERVIEW

Fluenta conducts a series of checks and calibrations to verify that the ultrasonic flare gas meter operates within the specified parameters and meets project requirements. The key steps include:

• Visual Inspection: Ensuring all components are intact, properly assembled, and conform to specifications.

• Functional Tests: Testing the field computer, ultrasonic transducers, and other system components.

• Calibration: Performing flow calibration on a Fluenta flow rig with air as the test medium to ensure accuracy in critical flow ranges.

• Performance Validation: Comparing test results against predefined criteria to validate performance.

## FLOW RIG DESIGN (APPENDIX A)

Our in-house flow rig is based at our warehouse in Gdańsk and comprises multiple sections, allowing for a range of transducer configurations, PP and PT sensors, a highly accurate and regularly calibrated reference meter, and a robust and reliable fan system.

A 12" pipeline diameter was selected based on industry data, confirming that the most common pipe sizes encountered in flare systems are centred around 12 inches. This choice ensures that the calibration process aligns closely with real-world operational conditions, as recommended by API 14.10 (Flare Gas Metering) and ISO 10715 (Natural Gas Sampling Guidelines), which emphasize representative flow conditions for accurate flare metering.

Our 12" line allows for the generation of flow velocities and Reynolds numbers that reflect actual flare system dynamics, ensuring accuracy in the critical measurement range where precise monitoring is essential for regulatory compliance and emissions reporting under API 14.1 (Gas Measurement)

## HOW AND WHY RESULTS CAN BE SCALED

The results from the 12" calibration setup can be reliably scaled to other pipe sizes and flow conditions due to established principles in fluid dynamics and metering standardization, as prescribed by API MPMS (Manual of Petroleum Measurement Standards) and ISO 6976 (Calculation of Calorific Values, Density, and Wobbe Index from Composition):

## REYNOLDS NUMBER SIMILARITY (ISO 9300, API 14.10)

The Reynolds number (Re), which dictates flow behaviour, is a dimensionless parameter based on velocity, pipe diameter, and fluid properties.

API and ISO standards recognize that, by maintaining dynamically similar Reynolds numbers across different diameters, flow characteristics can be reliably extrapolated to other pipe sizes.

## ACOUSTIC PATH AND TIME-OF-FLIGHT SCALING (API 22.2, ISO 17089-1)

Fluenta's ultrasonic flare meters adhere to API 22.2 (Measurement of Hydrocarbon Fluids by Ultrasonic Flowmeters) and ISO 17089-1 (Measurement of Gas Flow by Ultrasonic Meters), both of which define how time-of-flight measurement and transducer positioning should be applied across varying pipe sizes.

The K-factor (calibration coefficient), determined during dry or wet calibration, ensures that measurement accuracy is preserved when scaling from a 12" test line to other diameters.

## VELOCITY DISTRIBUTION AND TURBULENCE MODELLING (API 14.3, ISO 9300)

API and ISO guidelines define how velocity profiles develop in different pipe sizes under turbulent conditions.

Since the 12" line is within the industry standard range, it produces velocity distributions that remain proportional across different diameters, ensuring scalability of calibration results.

## GAS PROPERTIES AND MEDIUM SCALABILITY (ISO 6976, API 21.1)

Air is used as the testing medium during Factory Acceptance Testing (FAT) because it is readily available, non-hazardous, and easy to control.

ISO and API standards dictate that scaling from air to hydrocarbons is valid as long as appropriate corrections are applied for density, viscosity, and compressibility.

ISO 6976 (Gas Properties Calculation) and API 21.1 (Electronic Gas Measurement) provide guidance on compensating for differences between calibration conditions and actual flare gas compositions.

## COMPLIANCE AND VERIFICATION

Fluenta's calibration process ensures compliance with international metrology standards, including:

• API MPMS Chapter 14.10 (Flare Gas Metering)

• ISO 17089-1 (Ultrasonic Meters for Gas Flow Measurement)

• ISO 6976 (Calculation of Calorific Values and Density)

By adhering to these industry-accepted methodologies, Fluenta ensures that calibration results from the 12" test line remain valid and scalable for accurate and reliable flare gas measurement across a variety of pipe sizes, flow conditions, and gas compositions.

## CONFIGURATION OPTIONS

Fluenta's calibration processes accommodates multiple configuration options to match customer needs:

• Bias-90 vs. Single-Path vs. Dual-Path Transducers:

• Dual-path systems provide enhanced accuracy by compensating for flow profile variations.

• Output Configurations:

o Modbus, HART, Current Loop, Pulse, and Frequency outputs are available.

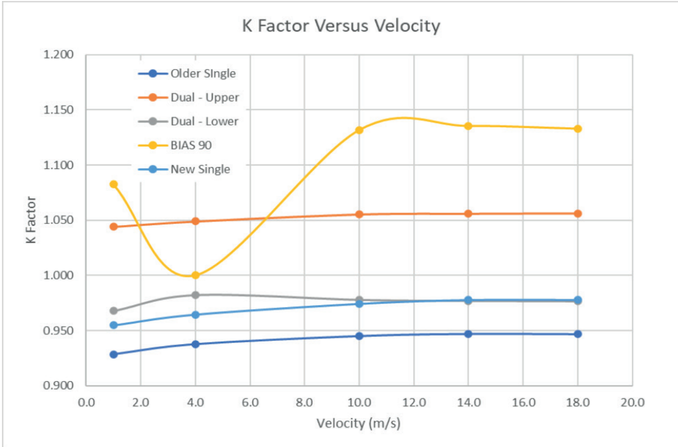
o Optional configurations include Foundation Fieldbus for advanced integrations.

• Pressure and Temperature Transmitters: These can be configured with HART or 4-20 mA interfaces to suit specific project requirements.

## VALIDATION OF TRANSFERABILITY

The results from our own flow rig are validated through a rigorous calibration process undertaken regularly at a third-party laboratory (VSL), where our own reference meter is tested against known flow speeds.

The relationship between axial velocity and path velocity is defined using CFD calculated curves:




This ensures that the measured flow profile is accurately converted to volume flow rates. Some deviation from linearity is seen with the BIAS-90 application, however, through k-factor compensation, this is still reasonable and well below the accuracy target of 1%.

Flow characteristics measured on the 12" line are extrapolated to the actual pipe size using further CFD modelling and industry-standard formulas. This guarantees that the actual FAT results reflect real-world operational conditions.