

of **Bronkhorst High-Tech B.V.**
Bronkhorst Calibration Centre

This annex is valid from: **23-08-2023** to **01-06-2026**

Replaces annex dated: **19-05-2022**

Location(s) where activities are performed under accreditation

Head Office	
Nijverheidsstraat 1A 7261 AK Ruurlo Netherland	
Location	Abbreviation/ location code
Nijverheidsstraat 1A 7261 AK Ruurlo Netherland	RU

HCS code	Measured quantity, Instrument, Measure	Range	CMC¹	Remarks	Location
FG 1 0	FLOW OF GAS				RU
FG 1 1	Gas volume flow rate	0.16 ml/min – 108 ml/min	0.55% – 0.30%	Piston Prover	
		5.4 ml/min – 33 l/min	0.30% – 0.25%	Piston Prover	
		0.22 m ³ /h – 431 m ³ /h	0.35 % – 0.25 %	Rotary Meter	
FG 1 1	Gas mass flow rate	0.15 ml _n /min – 100 ml _n /min	0.55% – 0.30 %	Piston Prover	
		5.0 ml _n /min – 30 l _n /min	0.30 % – 0.25 %	Piston Prover	
		0.2 m ³ _n /h – 400 m ³ _n /h	0.35 % – 0.25 %	Rotary Meter	

This annex has been approved by the Board of the
 Dutch Accreditation Council, on its behalf,

J.A.W.M. de Haas

¹ Calibration and Measurement Capability (CMC): Demonstrated measurement uncertainty, with coverage probability of 95%, in a given measurement point or measurement range. Measurement uncertainty, *U*, is calculated according to EA-4/02 "Evaluation of the Uncertainty of Measurement in Calibration".

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HCS code	Measured quantity, Instrument, Measure	Range	CMC ¹	Remarks	Location
FL 1 0	FLOW OF LIQUIDS				RU
FL 1 1	Liquid mass flow rate	(1 – 2) g/h	0.65%	Balance	
		(2 – 10) g/h	0.35%	Balance	
		(0.01 – 30) kg/h	0.10%	Balance	
PV 0 0	PRESSURE AND VACUUM				RU
PV 1 1	Absolute gas pressure	(2.5 – 3500) kPa	$5 \cdot 10^{-4} \cdot p + 80 \text{ Pa}$	Pressure Calibrator	
		(0.1 – 41.5) MPa	$5 \cdot 10^{-4} \cdot p + 1.4 \text{ kPa}$	Pressure Calibrator	
PV 1 2	Over atmospheric gas pressure	(-97.5 – 3400) kPa	$5 \cdot 10^{-4} \cdot p_e + 80 \text{ Pa}$	Pressure Calibrator	
		(0 – 41.4) MPa	$5 \cdot 10^{-4} \cdot p_e + 1.4 \text{ kPa}$	Pressure Calibrator	

Remarks

The ambient temperature and humidity during calibration is: 21 °C ± 2 °C and 50 %rh ± 20 %rh resp.

Calibration gases:

For Piston prover: Compressed dry Air, Ar, N₂, CO₂, H₂ or He; other gases on request

For Rotary meter: Compressed dry Air only

The flow units ml_n/min and l_n/min refer to gases under normal (n) conditions of 273.15 K and 101325 Pa.

Fixed normal densities ρ_n [kg/m³] are used to convert from the flow unit [l_n/min] to the mass flow unit [g/h], using the equation:

$$\Phi_m \left[\frac{\text{g}}{\text{h}} \right] = \Phi_v \left[\frac{\text{l}_n}{\text{min}} \right] \cdot \rho_n \left[\frac{\text{kg}}{\text{m}^3} \right] \cdot 60$$

For example:

Gas	Normal density [kg/m ³]	Equivalent [g/h] to 1 [l _n /min]:
Compressed dry air (AiR)	1.293	77.58
Argon (Ar)	1.784	107.0
Nitrogen (N ₂)	1.250	75.02
Carbon dioxide (CO ₂)	1.977	118.6
Hydrogen (H ₂)	0.08991	5.395
Helium (He)	0.1785	10.71

This way, any flow of any gas in [l_n/min] can be converted into mass flow in [g/h].