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CALIBRATION CERTIFICATE

N° F013110 / 26

Issued for : **BIOS INTERNATIONAL CORPORATION**
10 Park Place
BUTLER, NJ 07405
USA

CALIBRATED INSTRUMENT

Designation :	**DryCal**		
Manufacturer :	**BIOS**		
Type :	**ML-800-10**	Serial number :	**104087/103744**
		Identification :	-
This certificate includes	**5 pages**	Date of issue :	**18 May 2005**

Le Chef de la Division
Métrologie Chimique

Gilles HERVOUËT

The Calibration Officer

Jean BARBE

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1. IDENTIFICATION OF THE INSTRUMENT

The Piston Prover has the following characteristics :

- ML-800-10 Small Flow Cell n° 103744
- Nominal flow range : 5 - 500 sccm
- Volume flow reading at standard conditions (1013.25 hPa et 273.15 K)

2. CALIBRATION METHOD

The calibration of the piston prover is performed by comparison with the working standards type Molbloc^{TM} No. 689 of measuring range 0 - 10 sccm, No. 1001 of measuring range 0 - 50 sccm, No. 481 of measuring range 0 - 100 sccm and No. 1168 of measuring range 0 - 500 sccm, and connected to the support units type Molbox 1 n° 310 and 698.

It is recalled that the calibration of the working standards has been performed by dynamic gravimetric method (see certificate No. E013101 / 30, E013101 / 48, E013101 / 53, and E013101 / 55). The expanded uncertainty of the mass flow of these working standards is $\pm (3.10^{-5} + 4.5.10^{-3}.q_m)$ between 0.03 mg/s and 0.2 mg/s (No. 689) and between 0.1 mg/s and 0.4 mg/s (No. 1001), and $\pm (7.10^{-4} + 3,0.10^{-3}.q_m)$ between 0.4 mg/s and 1 mg/s (No. 1001), between 0.4 mg/s and 2 mg/s (No. 481) and between 1 mg/s and 10 mg/s (No. 1168).

According to custom, the mass flow is calculated in volume flow at standard conditions (1013.25 hPa et 273.15 K).

3. CALIBRATION CONDITIONS

- Dry gas : Nitrogen of purity 99,999 % ($M=25.0135\ g.mol^{-1}$; $R=8.31447\ J.mol^{-1}.K^{-1}$)
- Gas compressibility factor at 0 °C (Z_n) : 0.9995
- Ambient gas temperature: between 20.7 °C and 21.0 °C
- Absolute gas pressure : between 1002.4 hPa and 1009.9 hPa downsteam of the prover (atmospheric pressure)
- Setting up : downstream of the working standards and flow needle valve upstream of the prover

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4. CALIBRATION PROCEDURE

The calibration includes 3 cycles of 7 measurements with at least 4 successive determinations of the reference flow per flow point.

5. RESULTS

The results are reported in a table that shows for each flow level, the relationship between the mean reference mass flow indicated by the working standard and calculated in volume flow at standard conditions and the reading of the instrument at the same conditions, as the measurement uncertainty on this value and the relative deviation.

ML-800-10 Small Cell No. 103744 calibrated with nitrogen on 11 October 2004 by J. Couette

Reference mass flow (q_{mr}) mg/s	Calculated volume flow (q_{vr}) sccm	Volume flow reading sccm	Expanded uncertainty sccm	Relative deviation $(q_{vi} - q_{vr})/q_{vr}$ %
0.10494	5.035	5.028	0.026	- 0.13
0.20900	10.028	10.022	0.048	- 0.06
0.31194	14.967	14.965	0.070	- 0.01
0.52330	25.109	25.10	0.11	- 0.03
1.0471	50.240	50.24	0.23	0.00
2.5963	124.57	124.50	0.42	- 0.05
10.409	499.37	498.6	1.6	- 0.16

$$\text{With}: q_v = q_m . \frac{ZnR}{M} . \frac{273.15}{101325} .6.10^4$$

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ML-800-10 Small Cell No. 103744 calibrated with nitrogen on 12 October 2004 by J. Couette

Reference mass flow (q_{mr}) mg/s	Calculated volume flow (q_{vr}) sccm	Volume flow reading sccm	Expanded uncertainty sccm	Relative deviation $(q_{vi} - q_{vr})/q_{vr}$ %
0.10498	5.037	5.024	0.026	- 0.25
0.20947	10.050	10.040	0.048	- 0.10
0.31212	14.976	14.964	0.069	- 0.08
0.52095	24.995	24.97	0.11	- 0.10
1.0460	50.185	50.17	0.23	- 0.02
2.6155	125.49	125.40	0.42	- 0.07
10.357	496.93	496.3	1.6	- 0.12

$$\text{With}: q_{vr} = q_{mr} \cdot \frac{ZnR}{M} \cdot \frac{273.15}{101325} \cdot 6.10^4$$

ML-800-10 Small Cell No. 103744 calibrated with nitrogen on 25 March 2005 by J. Couette

Reference mass flow (q_{mr}) mg/s	Calculated volume flow (q_{vr}) sccm	Volume flow reading sccm	Expanded uncertainty sccm	Relative deviation $(q_{vi} - q_{vr})/q_{vr}$ %
0.10469	5.023	5.018	0.027	- 0.10
0.20904	10.030	10.030	0.047	0.00
0.31080	14.912	14.920	0.069	+ 0.05
0.52330	25.108	25.11	0.11	0.00
1.0458	50.176	50.18	0.24	+ 0.01
2.6042	124.95	125.03	0.42	+ 0.07
10.394	498.69	498.2	1.6	- 0.11

$$\text{With}: q_{vr} = q_{mr} \cdot \frac{ZnR}{M} \cdot \frac{273.15}{101325} \cdot 6.10^4$$

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The reported uncertainties are stated as the standard uncertainties multiplied by a factor 2. The standard uncertainties were calculated using the different sources of uncertainties, reference standards, calibration devices, environmental conditions, the contribution of the calibrated instrument, repeatability...

The issuance of a COFRAC calibration certificate guarantees the traceability of the calibration results to the national standards.

End of calibration certificate