# On-site calibration and verification of mass flowmeter for aerosol samplers

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## CT2M in figures

**1993** : creation

**11** people

**660** people trained in 2022

**3074** masses calibrated in 2022

**5** CIL organized in 2022

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## Training / Consulting / Audit@

« Supporting companies and laboratories in their Quality and Metrology projects »

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Qualiopi processus certifié

*« Actions de formation »*

## Proficiency Testing provider (PT)

« Organization of PT in accordance with ISO 17043 and with COFRAC accreditation for mass calibration from 1 mg to 20 kg »

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cofrac COMPARAISONS INTERLABORATOIRES

*Accreditation N° 1-7127*
*Scope available on www.cofrac.fr*

## Mass calibration until E2 class

*« Calibration and verification of masses from 1 mg to 5 tons with COFRAC accreditation »*

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cofrac ÉTALONNAGE

*Accreditation N° 2-1292*
*Scope available on www.cofrac.fr*

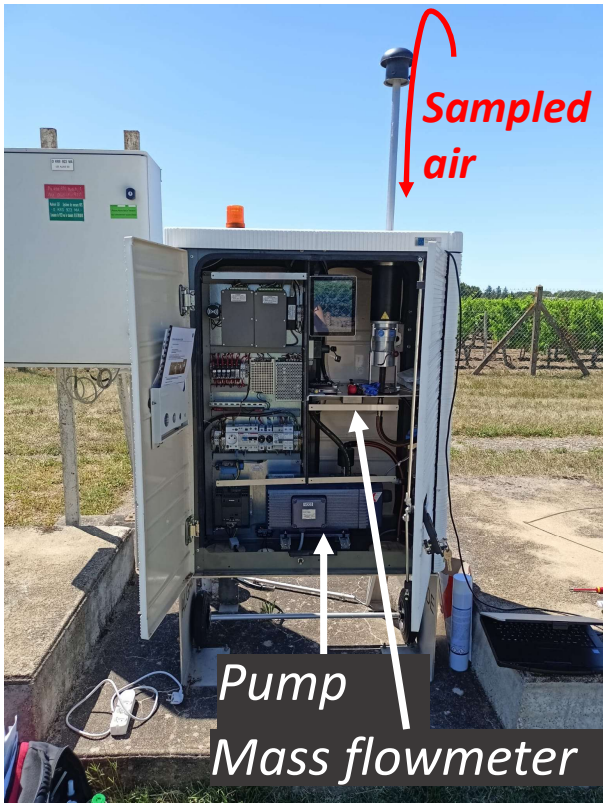
Context : Measurement of radioactivity in the environment

Measurement : global alpha / beta radioactivity index or gamma emitters in environmental samplers

Unit: **Bq/Nm³** (Normal Meter Cubed)

→ Volume of air

→ Aerosol sampler →




Metrological traceability of the volume must be guaranteed

↓

**Mass flowmeter calibration (on-site)**

**Problems encountered by the company**

Calibration laboratories of mass flowmeter are accredited “in laboratory” and not “on site” (aerosol sampler cannot be moved).

***Studie***

Internal calibration of mass flowmeter

**Requirements of GEN REF 10 (COFRAC document based on ILAC P/10*)**

Appropriate evidence for the technical competence to perform internal calibration and metrological traceability should include ISO 17025 requirements.

**ILAC Policy on Metrological Traceability of Measurement Results*

## Requirements of GEN REF 10 (COFRAC document based on ILAC P/10*)

Appropriate evidence for the technical competence to perform internal calibration and metrological traceability should include ISO 17025 requirements.

1) Metrological criteria
2) Calibration method of mass flowmeter (+ environmental conditions)
3) Calibration results
4) Calibration uncertainty
5) Statement of compliance

**ILAC Policy on Metrological Traceability of Measurement Results*

# 1) Metrological criteria:

*Requirements of the NF M 60-760* standard:*

| Requirement on: | Criteria | Value |
|---|---|---|
| Volume measurement of air sample | Relative uncertainty | < 5% (k=1) |
| Proper functioning of the flow control device | Deviation from the set point | ~~±10%~~ |

***Company criteria : ±2%***

**NF M 60-760 (2017): Nuclear energy - Measurement of radioactivity in the environment - Air - Sampling of aerosols for measurement of radioactivity in the environment*

## 2) Calibration method of mass flowmeter:

3 tests are carried out with a mass flowmeter standard:

- Flow calibration (in $Nm^3/h$)
- Volume control (in $Nm^3$)
- Control of flow regulation (in $Nm^3/h$)

→ *Time quantity is not calibrated because the internal clock error is insignificant.*


*Mass flowmeter standard*

# 2) Calibration method of mass flowmeter:

**Measuring range :**

- based on ±10% deviation criteria
- Set point : 6,25 $Nm^3/h$

→ **5,6 to 6,9 $Nm^3/h$**

**Calibration point:**

- Flow calibration (in $Nm^3/h$)
- Control of flow regulation (in $Nm^3/h$)

→ **5,6 $Nm^3/h$**
**6,25 $Nm^3/h$**
**6,9 $Nm^3/h$**

↳ Modification of the set point locked in the software

# 2) Calibration method of mass flowmeter + environmental conditions

**Environmental conditions:**

- Air temperature between 15°C and 25°C
- Absence of strong winds
- Avoid humid periods

→ **Hard to control**

→ Calibration period must be adjusted

**Operating mode:**

- Flow calibration (in $Nm^3/h$) :
- Control of the flow regulation (in $Nm^3/h$)

→ **10 measurements on each massflowmeter / 1 min:**
- $fm_1$ to $fm_{10}$ for massflowmeter to calibrate
- $fs_1$ to $fs_{10}$ for massflowmeter standard

- Volume control (in $Nm^3$)

→ **1 measurement at the beginning and 1 measurement at the end of the calibration ($V_1$ + $V_{10}$)**

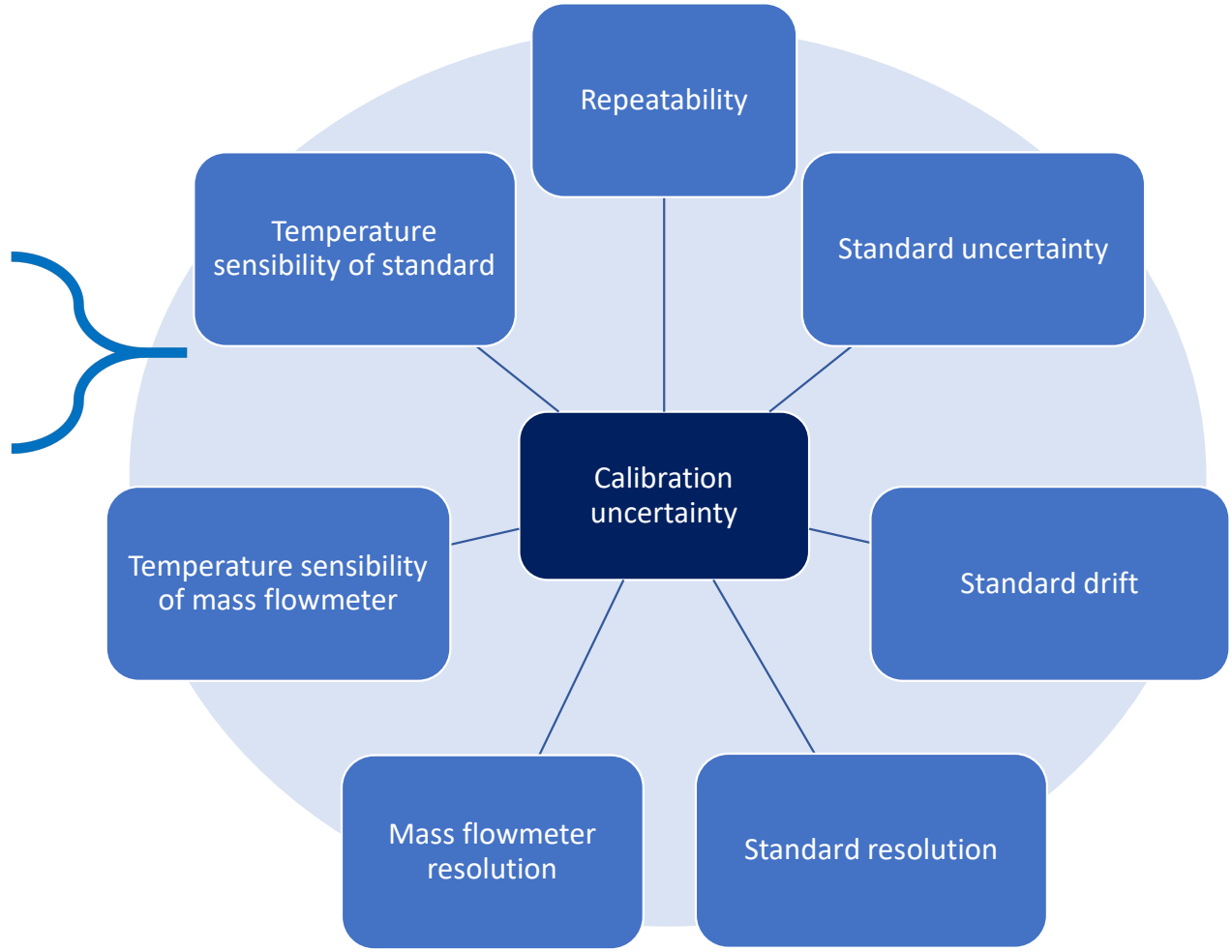
# 3) Calibration results:

- Flow calibration (in $Nm^3/h$) → **Measurement bias « $b_{flow}$ »**
- Volume control (in $Nm^3$) → **Measurement bias « $b_{vol}$ »**
- Control of flow regulation (in $Nm^3/h$) → **Deviation from the set point « $d_{regul}$ »**

# 4) Calibration uncertainty:

## → GUM methodology

- Flow calibration : $U(b_{flow})$ in $Nm^3/h$
- Volume control : $U(b_{vol})$ in %




**Results example:**

Set point : 6,25 $Nm^3/h$

- $U(b_{flow})$ = 0,13 $Nm^3/h$
- $U(b_{vol})$ = 2,1 %

## 5) Statement of compliance:

**→ In relation to Maximum Permissible Error (MPE)**

- Flow calibration : $|b_{flow}| + U(b_{flow}) \leq MPE_{f,v}$
- Volume control : $|b_{vol}| + U(b_{vol}) \leq MPE_{f,v}$
- Control of the flow regulation : $|d_{regul}| \leq MPE_{d}$

# 5) Statement of compliance:

## → Determination of Maximum Permissible Error on flow and volume ($MPE_{f,v}$)

- Criteria :

| Requirement on: | Criteria | Value |
|---|---|---|
| Volume measurement of air sample | Uncertainty | < 5% (k=1) |

- Evaluation of air sample volume uncertainty:

$$u_{rel}(massflowmeter) = \frac{MPE_{f,v}}{\sqrt{3}}$$

$$u_{rel}(flow\ variability) = \frac{MPE_d}{\sqrt{3}}$$

u(massflowmeter)

u(flow variability)

Volume uncertainty

$u_{rel}$(volume of air sample) < 5% (k=1) with $MPE_{f,v}$ = 8%, $MPE_d$ = 2%

# CONCLUSION

- **Development of an internal method for on-site mass flowmeter calibration** :
  - ✓ Validation of calibration method
  - ✓ Evaluation of measurement calibration uncertainty
  - ✓ Documentation and records for metrological traceability of measurement results
  - ✓ Documentation and records for competence of personnel
  - ✓ Documentation for facilities and environmental conditions

- **Areas of improvement :**
  - ✓ Software access
  - ✓ Uncertainty evaluation
  - ✓ Environmental condition control