# PRODUCT CONFORMITY CERTIFICATE

This is to certify that the

## *Smart Heated $PM_{10}$ BAM-1020*

Manufactured by:

## *Met One Instruments, Inc*

1600 NW Washington Blvd
Grants Pass
Oregon 97526
USA

has been assessed by Sira Certification Service
And for the conditions stated on this certificate complies with:

**MCERTS Performance Standards for Continuous Ambient Air Quality Monitoring Systems, Version 10 dated June 2016**

**MCERTS for UK Particulate Matter as set out in the Annex to the MCERTS Performance Standards for Ambient Air Quality Monitoring Systems: Requirements of the UK Competent Authority for the Equivalence Testing and Certification of Automated Continuous and Manual Discontinuous Methods that Monitor Particulate Matter in Ambient Air, Version 1.1, dated 31 July 2012**

Certification Ranges :

| | |
|---|---|
| $PM_{10}$ | 0 to 1000 µg/m$^3$ |

| | |
|---|---|
| Project No.: | 16A33318/80006204 |
| Certificate No: | Sira MC140254/02 |
| Initial Certification: | 01 August 2014 |
| This Certificate issued: | 31 July 2019 |
| Renewal Date: | 31 July 2024 |

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Environmental Project Engineer

MCERTS is operated on behalf of the Environment Agency by

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Form 1335
Issue 7

**Certificate Contents**



## Approved Site Application

*Any potential user should ensure, in consultation with the manufacturer, that the monitoring system is suitable for the intended application. For general guidance on monitoring techniques refer to the Environment Agency Monitoring Technical Guidance Notes available at www.mcerts.net*

The $PM_{10}$ field test was conducted at one site in the UK, three sites in Germany, two in Austria and one in the Czech Republic. The particulate loading at the test sites is representative of different types of areas including urban background, roadside, rural and industrial. The testing took place in both winter and summer months.

On the basis of these tests this certificate is valid when the instrument is used for urban, industrial and rural air quality monitoring and similar applications.

The requirements according to the Guide To The Demonstration Of Equivalence Of Ambient Air Monitoring Methods (GDE 2010) are fulfilled for $PM_{10}$.

## Basis of Certification

This certification is based on the following Test Report(s) and on Sira's assessment and ongoing surveillance of the product and the manufacturing process:

| | |
|---|---|
| MCERTS certification committee Report | Certification Report and Checklist on the Evaluation of the Ambient Air Particulate Matter Monitor Test Reports for the Smart Heated $PM_{10}$ BAM-1020 Submitted for Approval and Certification within the MCERTS Scheme for UK Particulate Matter: Requirements of the UK Competent Authority for the Equivalence Testing of Methods that Monitor Particulate Matter in Ambient Air, 30th May 2014 |
| Bureau Veritas | UK Report on the Equivalence of the Smart Heated $PM_{10}$ BAM-1020. Report ref AGGX5590185/BV/DH/2882 dated 31 May 2014 |
| TÜV Rheinland | Report on the suitability test of the ambient air quality measuring system BAM-1020 with $PM_{10}$ pre-separator of the company Met One Instruments, Inc. for the measured component suspended particulate matter $PM_{10}$ |

| | |
|---|---|
| | TÜV-Report: 936/21205333/A dated December 06, 2006<br>Report published on www.qal1.de/en/hersteller/metone.htm |

| | |
|---|---|
| TÜV Rheinland | Addendum to the type approval test report of the measuring system BAM-1020 with $PM_{10}$ pre-separator of the company Met One Instruments, Inc. for the component $PM_{10}$ to the TÜV-report 936/21205333/A of Dec 06, 2006.<br>TÜV-Report: 936/21220762/A dated December 12, 2012<br>Report published on www.qal1.de/en/hersteller/metone.htm |

## Product Certified

The instrument tested was the BAM-1020 measuring system consisting of the following parts:

- USEPA style $PM_{10}$ sampling inlet operating at 16.67 l/min with louvered slats to prevent rain ingress;
- Sampling tube;
- Smart Heated Inlet (Part number BX830) set to limit the maximum relative humidity RH at the filter tape to 45 % Smart heated inlet control by Delta T was set to 'NO'
- Ambient temperature sensor (BX-592), or optionally the combined pressure and temperature sensor (BX-596);
- BAM-1020 Beta Attenuation Mass Measuring system incorporating glass fibre filter tape programmed to perform hourly measurements with an 4 minute beta attenuation measurement at the beginning and end of every 50 minute sampling period;
- Vacuum pump and airflow controller set to ambient conditions.

The operation of instruments in permutations other than the above is not covered by this report, and is not recommended for approval without further consideration by the UK Certification Committee for the implications of any variations.

The standard filter tape used in the Met One BAM 1020 series of particulate monitors is made from glass fibre, which is commonly available. However, the filter tape used in the BAM 1020 series of instruments has critical and customised characteristics, and as such, all filter tapes should be obtained directly from Met One or from one of its authorised dealers. Met One has historically supplied a standard filter tape (product number 460130, manufactured by Sibata in Japan). This was employed in all the seven field test programmes discussed in this certificate. Thus in principle, this type of filter tape should be employed in any future use of instruments as equivalent methods. However, Met One has more recently qualified one additional tape manufacturer (Whatman, Germany, product number 460180) which has proven to be fully equivalent in terms of its physical properties, and also in terms of the filter tape producing equivalent results for ambient atmospheric particulate monitoring of $PM_{10}$. The evidence supporting this has been reviewed in this Evaluation and considered to be satisfactory. This certificate requires the use of one of the designated filter tapes discussed above in order to be approved within the scope of the MCERTS for UK Particulate Matter document.

This certificate applies to all Smart Heated $PM_{10}$ BAM-1020 instruments with serial number D0001onwards and fitted with Software Version 3236-02 3.2.1b onwards. It is however recommended that operators install the latest approved versions of the Software approved for the instrument; namely: Software Version 3236 V5.2.0 for those equipped with a touch screen display and Software Version 3236-07 5.1.1 for those that do not have a touch screen display. Future versions could be accepted if they are approved comprehensively during the annual audit of the manufacturing facility.

## Certified Performance

The instrument was evaluated for use under the following conditions:

Ambient Temperature Range: 5°C to 40°C

| Test | Results | MCERTS specification |
|---|---|---|
| Constancy of the sample volumetric flow | 2.5% | To remain constant within ± 3% of the rated value |
| Tightness of the sampling system | 0.6% maximum | Leakage not to exceed 1% of the sampled volume |
| Maintenance interval | One Month | ≥Two weeks |
| Data Availability | 98.8% | ≥90% |
| Number of UK Tests | 1 | ≥1 |
| Number of Reference Methods | 2 for all sites but Tusimice where there was 1 | ≥1 |
| Between sampler/instrument uncertainty for the standard method **$PM_{10}$** | | |
| Full data set | 0.59 µg/m$^3$ | ≤2 µg/m$^3$ |
| <30 µg/m$^3$ | 0.43 µg/m$^3$ | Not specified |
| ≥30 µg/m$^3$ | 0.84 µg/m$^3$ | Not specified |

| Test | Uncorrected | Slope Corrected | MCERTS specification |
|---|---|---|---|
| Between sampler/instrument uncertainty for the candidate method **$PM_{10}$** | | | |
| Full data set | 1.29 µg/m$^3$ | 1.24 µg/m$^3$ | ≤2.5 µg/m$^3$ |
| <30 µg/m$^3$ | 1.14 µg/m$^3$ | 1.10 µg/m$^3$ | ≤2.5 µg/m$^3$ |
| ≥30 µg/m$^3$ | 1.58 µg/m$^3$ | 1.53 µg/m$^3$ | ≤2.5 µg/m$^3$ |
| Expanded uncertainty calculated at 50 µg/m3 for **Instrument Austria1** | | | |
| Full data set | 16.0% | 15.8% | ≤25% |
| <30 µg/m$^3$ | 42.8% | 33.9% | Not specified |
| ≥30 µg/m$^3$ | 19.6% | 20.1% | ≤25% |
| Individual sites | | | |
| Graz | 20.9% | 20.0% | ≤25% |
| Steyregg | 9.3% | 9.8% | ≤25% |
| Expanded uncertainty calculated at 50 µg/m3 for **Instrument Austria2** | | | |
| Full data set | 19.8% | 17.3% | ≤25% |
| <30 µg/m$^3$ | 62.9% | 52.6% | Not specified |
| ≥30 µg/m$^3$ | 22.7% | 20.7% | ≤25% |
| Individual sites | | | |
| Graz | 26.1% | 22.3% | ≤25% |
| Steyregg | 9.6% | 11.6% | ≤25% |

| Test | Uncorrected | Slope Corrected | MCERTS specification |
|---|---|---|---|
| Expanded uncertainty calculated at 50 µg/m3 for **Instrument J7860** | | | |
| Full data set (Tusimice) | 18.5% | 13.2% | ≤25% |
| <30 µg/m$^3$ | 40.5% | 32.4% | Not specified |
| ≥30 µg/m$^3$ | 17.7% | 13.0% | ≤25% |
| Expanded uncertainty calculated at 50 µg/m3 for **Instrument J7863** | | | |
| Full data set (Tusimice) | 18.2% | 12.7% | ≤25% |
| <30 µg/m$^3$ | 33.7% | 26.1% | Not specified |
| ≥30 µg/m$^3$ | 18.0% | 12.9% | ≤25% |
| Expanded uncertainty calculated at 50 µg/m3 for **Instrument 17011** | | | |
| Full data set (Teddington) | 30.0% | 22.4% | ≤25% |
| <30 µg/m$^3$ | 11.1% | 5.5% | Not specified |
| ≥30 µg/m$^3$ | Only 1 data point | Only 1 data point | ≤25% |
| Expanded uncertainty calculated at 50 µg/m3 for **Instrument 17022** | | | |
| Full data set (Teddington) | 22.3% | 15.1% | ≤25% |
| <30 µg/m$^3$ | 13.5% | 7.2% | Not specified |
| ≥30 µg/m$^3$ | Only 1 data point | Only 1 data point | ≤25% |

Note 1: The instruments tested were operated with the default measurement range of 0 to 1000 µg/m$^3$ for hourly measurements. The maximum 24 hour average concentration recorded during the tests was 128.7 µg/m$^3$.

Note 2: The CM does not fulfil the relevant Data Quality Objective of EU Directive 2008/50/EC when used without correction, therefore test results were also subjected to correction for each of intercept, slope and both slope and intercept. Expanded uncertainties for the Candidate Method were calculated for both uncorrected datasets as well as data that have been adjusted for slope and/or intercept. **Slope correction of dividing by 1.035 is required in order to make the Smart Heated $PM_{10}$ BAM-1020 equivalent.** It is not necessary to correct for intercept, but it is essential that thorough and frequent on-going QA/QC procedures are employed (as prescribed in fprEN12341:2014 and CEN/TS16450) including to precisely quantify analyser baseline performance and ensure that the instrument specific baseline correction factor programmed in to the instrument is correctly monitored and maintained.

| **$PM_{10}$ Smart BAM-1020** | Calculated slope of all paired data | Calculated intercept of all paired data | Expanded uncertainty of all paired data | Range of individual expanded uncertainties |
|---|---|---|---|---|
| Uncorrected data | 1.035 | 0.947 | 17.4% | 9.3% to 30.0% |
| Data corrected for intercept by subtracting 0.843 | 1.035 | 0.000 | 15.4% | 9.0% to 26.3% |
| Data corrected for slope by dividing by 1.034 | 1.000 | 0.924 | 13.8% | 9.8% to 22.4% |
| Data corrected for slope and intercept by subtracting 0.843 and then dividing by 1.034 | 1.000 | 0.009 | 13.4% | 11.4% to 21.6% |

Note 3: In order to be consistent with the 2012 TÜV Rheinland Report the instruments tested have been referred to by the serial numbers and acronyms provided by the site operators. The true serial numbers as designated by the manufacturer and the corresponding manufacture year are summarised in the following Table.

| Descriptor assigned in this report | Serial number assigned by manufacturer | Build Year |
|---|---|---|
| Austria 1 | G8210 | 2007 |
| Austria 2 | G8211 | 2007 |
| J7860 | J7860 | 2009 |
| J7863 | J7863 | 2009 |
| 17011 | G2757 | 2007 |
| 17022 | G4044 | 2007 |

Note 4: A study of pollution climate relevant to sites in the UK, the Czech Republic, and Austria has demonstrated that in all cases the particulate geometric mean criteria are met and at least one site meets the lower threshold and higher threshold criterion for wind speed, ambient temperature, ambient dew point and semi volatile nitrate content. The pollution climate criteria are satisfied for all the equivalence tests.

Note 5: For the purposes of quality control of these monitors in the field, as with all PM instruments that are not the reference method, the Smart Heated $PM_{10}$ BAM-1020 should be calibrated on a test site at intervals against the gravimetric reference methods EN 12341 or EN 14907 as applicable, and as given in the recommendations of the GDE 2010 and CEN/TS16450.

Note 6: Three German datasets of Cologne Parking Lot; Titz-Rödingen; and Cologne Frankfurter Strasse each had fewer than the required 40 data points, but were included in the 2012 TÜV Rheinland Report at the request of the German Certification Committee. The conclusion of the TÜV Rheinland Report when considering all seven datasets was that slope correction of dividing by 1.034 is required in order to make the instrument equivalent. For UK purposes it is necessary to consider only those datasets with greater than 40 data points. It has been shown that when considering only the four datasets with greater than 40 data points that it is required to slope correct by a slightly different constant; namely: **slope correction of dividing by 1.035 is required in order to make the Smart Heated $PM_{10}$ BAM-1020 equivalent.**

Note 7: A comprehensive set of laboratory tests were undertaken by TÜV Rheinland and are discussed in the TÜV Rheinland report. It is not necessary to review the results of these tests under the MCERTS for UK Particulate Matter certification scheme.

## Description

The Smart Heated $PM_{10}$ BAM-1020 Ambient Particulate Monitor is used to sample $PM_{10}$ by using a 16.7 l/min USEPA style $PM_{10}$ inlet. The system uses smart heating technology in order to limit the maximum relative humidity RH at the filter tape to 45 %. The instrument utilizes glass fibre tape.

The ambient air measuring system BAM-1020 is based on the measuring principle of beta-attenuation. The principle of the radiometric determination of mass is based on the physical law of attenuation of beta-rays when passing a thin layer of material. There is the following relationship:

$$c\left(\frac{\mu g}{m^3}\right) = \frac{10^6 A(cm^2)}{Q\left(\frac{l}{min}\right)\Delta t(min)\mu\left(\frac{cm^2}{g}\right)} \ln\left(\frac{I_0}{i}\right)$$

where:

| | |
|---|---|
| C | particle-mass concentration; |
| A | sampling area for particles (filter spot); |
| Q | sampling flow rate; |
| $\Delta t$ | sampling time; |
| $\mu$ | mass absorption coefficient; |
| $I_0$ | beta count rate at the beginning (clean); |
| I | beta count at the end (collect). |

The radiometric determination of mass is calibrated in the factory. During routine operation of the instrument this is checked hourly both on the clean filter prior to collection of the sample and using the built-in reference foil. The values obtained can be compared with any stability requirements (such as drift effects) relative to the values obtained during factory calibration.

One measurement cycle (incl. automatic check of the radiometric measurement) consists of the following steps (setting: measuring time for radiometry 4 min):

1. The initial count of the clean filter tape I0 is performed at the beginning of the cycle for a period of four minutes.

2. The filter tape is advanced four windows and the sampling (vacuum pumping) begins on the spot in which I0 was just measured. Air is drawn through this spot on the filter tape for approximately 50 minutes.

3. At the same time the second count I1 occurs (at a point on the tape 4 windows back) for a period of four minutes. The purpose of the measurement is to perform the verification for instrument drift caused by varying external parameters such as temperature and relative humidity. A third count I2 occurs with the reference membrane extended over the same place on the tape. Four minutes before the end of sampling time, another count I1x occurs on the same point of the tape. With the help of I1 and I1x, the stability at the zero point can be monitored.

4. After sampling, the filter tape is moved back four windows to measure the beta ray absorption through the section that has collected dust (I3). Finally the concentration calculation is performed to complete the cycle.

5. The next cycle begins with step 1.

**General Notes**

1. This certificate is based upon the equipment tested. The Manufacturer is responsible for ensuring that on-going production complies with the standard(s) and performance criteria defined in this Certificate. The Manufacturer is required to maintain an approved quality management system controlling the manufacture of the certified product. Both the product and the quality management system shall be subject to regular surveillance according to 'Regulations Applicable to the Holders of Sira Certificates'.

2. The design of the product certified is held and maintained by TUV Rheinland for certificate No. Sira MC140254/XX

3. If certified product is found not to comply, Sira Certification Service should be notified immediately at the address shown on this certificate.

3. The Certification Marks that can be applied to the product or used in publicity material are defined in 'Regulations Applicable to the Holders of Sira Certificates'.

4. This document remains the property of Sira and shall be returned when requested by the company.