

Draft B

*Measurement Good Practice Guide No. xx*

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**The Examination and Testing of Equipment for Monitoring  
Airborne Radioactivity, Part 1: Airborne Radioactive  
Particulate in the Workplace - Abridged**



This Good Practice Guide has been written by a working party of the Airborne Radioactivity Monitoring Users' Group. Membership of the working party was as follows:

**Working Group**

Derek Brazer	AWE
Peter Burgess	UKAEA
Les Martin	British Nuclear Fuels plc.
Martin Oliver	Laboratory Impex Systems
Max Pottinger	British Nuclear Fuels plc.
David Ryden	Canberra-Harwell
John Simpson	RWE Nukem
Eliot Williams	UKAEA
Andrea Woodman	National Physical Laboratory
Mike Woods	National Physical Laboratory

**Writing Sub-Group**

Max Pottinger	British Nuclear Fuels plc.
Andrea Woodman	National Physical Laboratory
David Ryden	Canberra-Harwell

## Foreword

This Good Practice Guide has been written by the UK Airborne Radioactivity Monitoring Users' Group\* in collaboration with the radiation user community. It describes recommended procedures for the examination, testing and calibration of air monitoring equipment. Test procedures recommended in this document are not legally binding: they are general methods based on current accepted good practice.

The current statutory requirement for air monitoring equipment tests is stated in the Ionising Radiations Regulations 1999. All employers who work with ionising radiation must ensure that levels are adequately monitored and instruments are suitable for this purpose.

Although the testing regimes presented here are for general application, qualified persons responsible for the calibration of radiation protection instruments may modify them, with the agreement of the Radiation Protection Adviser, as necessary to suit their particular purpose, provided that the employer is satisfied that the overall quality of the testing is not compromised.

\* The Airborne Radioactivity Monitoring Users' Group consists of representatives of UK establishments and organisations actively involved in air monitoring for radioactivity, including monitoring for particulate or gaseous radioactivity at environmental, workplace and process control levels. It is the aim of the Group to facilitate the exchange of information regarding UK calibration facilities and their efficient use by those required to comply with these regulations.

# The Examination and Testing of Equipment for Monitoring Airborne Radioactivity, Part 1: Airborne Radioactive Particulate in the Workplace

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## 1 Introduction

The examination and testing of radiation protection instruments is a legal requirement for those carrying out work with ionising radiations<sup>1,2</sup>. Sufficient equipment must be available to comply with the regulations and the instruments must be examined, tested and calibrated at appropriate intervals to ensure that they remain fit for use. Many types of air monitoring equipment are either installed or not readily transportable, therefore it is often not possible to transport these instruments to a suitable calibration laboratory. Therefore, periodic examination and testing of such equipment will frequently be carried out in the workplace. This minimises risk of damage caused by removal, transport and re-installation of equipment: it also permits tests of auxiliary indicators, such as remote warning lights.

This Good Practice Guide provides recommended procedures for the general examination, testing and calibration of air monitoring equipment, which is used for the purpose of radiation protection. It follows a similar format to GPG14<sup>3</sup> and GPG29<sup>4</sup>, which provide advice for portable and installed dose rate and contamination radiation protection instruments respectively. Recommendations made in documents published by national and international organisations, including the International Electrotechnical Commission (IEC) have been consulted during the preparation of this Guide.

The procedures detailed in this guidance provide the minimum level of testing that is recommended for instruments used in normal operating conditions. There may be special cases where testing requirements will go beyond these recommendations, where instruments are used in conditions outside those envisaged in the standards above, such as emergencies. In such circumstances, the Employer may need to design alternative test procedures. The testing regimes contained herein have no legal standing and Employers may implement their own schemes, provided they ensure compliance with the relevant regulations.

The objective of testing is to demonstrate that the instrument is suitable and fit for use. The guide is intended to cover all equipment that is used to assess the concentration of airborne radioactive particulate in the workplace. Therefore it includes air samplers, air monitors and laboratory based counting equipment that is used to assess the quantity of radioactive particulate on filter papers. These types of instrument are

described in detail in Section 3. Further guides may be produced to cover equipment for other radioactivity in air monitoring applications, notably tritium in the workplace and possibly radioactive particulate in gaseous effluents. The examination and testing of personal air samplers is not covered in this Guide.

Some air monitors also perform non-air monitoring functions. For example, an air monitor may also measure ambient gamma dose rate. This guide does not cover the testing of these functions, although it is likely that they would be tested at the same time as the air monitoring functions.

## 2 Testing Regime

For the purposes of this guidance, a **test** is defined as a procedure to evaluate an instrument's performance in order to establish its suitability, or its continued fitness, for a particular type or types of measurement in operational radiation protection. A test may involve an element of **calibration**, which may be defined as the measurement of the response of the instrument to a known influence quantity, such as flow rate or activity. It is important to recognise that the terms **test** and **calibration** are not synonymous: this is because a test will also involve a degree of **examination**, which may include, for example, an inspection of the mechanical and electrical state of the instrument.

Air monitoring equipment should undergo Tests Before First Use (TBFU) and subsequently Periodic Tests, which should be performed at suitable intervals in compliance with current national regulations and associated codes of practice. The findings of these tests must be compared with any previous test information and the appropriate Type Tests to confirm that the instrument is meeting its specification and is suitable for its intended use. The Type Tests are normally carried out by or on behalf of the instrument manufacturer. TBFU and periodic tests are carried out by or on behalf of the Employer. Table 1 lists recommended TBFU and Periodic tests.

It is recommended that additional Function Checks are carried out more frequently to ensure that the instrument remains fit for use.

A full record of test results including details of any adjustments made to the instrument should be kept for a period to be determined by the Employer.

### 2.1 Type Tests

Before purchasing an instrument, it is the responsibility of the Employer to ensure that it is suitable for the intended use. Decisions about instrument selection should be made taking into account advice from the Radiation Protection Adviser (RPA), information from the manufacturer and other authoritative data that might be available.

The body of information regarding the characteristics and expected performance of instruments is called Type Test data and is usually based on recommendations from international organisations such as IEC, ISO, etc. A number of IEC documents exist which detail the tests that are appropriate for the Type Testing of particular types of instrument. Typical documents for testing air monitoring equipment are IEC 61172<sup>5</sup> for radioactive particulate air monitors used within the environment and IEC 60761 parts 1<sup>6</sup> and 2<sup>7</sup> for radioactive particulate in effluent. There are no IEC standards specific to laboratory counting equipment, although much of the equipment is similar in principle to portable contamination monitoring equipment, which are covered by IEC 60325<sup>11</sup>. Type Tests are very comprehensive and may require specialised facilities: the tests should be performed by someone with appropriate expertise and insight into the use of instruments, in a laboratory with secondary standard or similar status, for example, a laboratory accredited by UKAS, using International Commission on Radiological Units and Measurements (ICRU) specified measurement quantities and ISO specified calibration sources.

The results of any tests carried out during the lifetime of an instrument should be compared with Type Test data to ensure that it continues to operate as expected; therefore, it is necessary to have access to the Type Test data for each instrument tested. As a minimum requirement the Type Test data should include results of tests that are equivalent to those defined in this guide as TBFU (see Table 1).

For most new instruments, the manufacturers, suppliers or other organisations may provide Type Test data that will enable the Employer to decide the necessary scope of TBFU. In the absence of Type Test data, the Employer should perform their own Type Test to establish their own baseline data at the TBFU stage.

## **2.2 Tests Before First Use**

The TBFU are intended to demonstrate that the instrument conforms to type and is suitable for its intended use.

These tests should provide a check for any potential faults and identify any limitations of the instrument with respect to its intended use. The tests may be undertaken by the manufacturer, the Employer or an independent laboratory.

Table 1 summarises the tests required for the TBFU of air samplers, air monitors and laboratory counting equipment. The recommended procedures for each of the tests are provided in Sections 4 and 5. Some of these tests may need to be repeated periodically as the performance of an instrument can vary with age, key components may deteriorate or fail, and damage may occur during use: these are some of the reasons for the subsequent Periodic Tests.

### **2.3 Periodic Tests**

It is the responsibility of the Employer to define the frequency of Periodic Tests based upon considerations of the age of the equipment, the environment in which it is used, the frequency of use, etc. It is the recommendation of this guidance that examination, testing and calibration should be performed at least annually. However, the requirements of any regulations published in the future must be adhered to.

The purpose of Periodic Testing is to check that the performance of an instrument has not significantly changed and remains fit for use, and to confirm the performance has not changed significantly since the TBFU.

The tests required for the Periodic Tests are summarised in Table 1 and are generally similar to those for the TBFU. Specific details of each test are provided in Sections 4 and 5.

Because the instrument may have suffered from wear and tear or misuse, attention should be paid to the performance and the condition of its electrical and mechanical systems. For example, the pump within the air circuit of an air sampler or monitor is particularly vulnerable to wear and tear, and should be examined at least once per year. The condition of any warning lights/audible alarms should also be checked, and any lights or indicators to which a user has to respond must be operating correctly. If the instrument is normally connected to other components such as remote alarms, data logging systems, etc then additional tests for the relevant input/output functions should be included.

## **2.4 Function check**

A function check is a simple test carried out to ensure with the minimum of interference that the instrument is working correctly. The frequency of function checks must fit the application of the instrument and must be determined by the Employer. Function checks may involve the following:

- Response check
- Background check
- Flow rate check
- Alarm check

If the function check results fall outside prescribed limits, the instrument should be submitted for a Periodic Test. If the instrument requires a repair or maintenance, the Qualified Person should consider whether another TBFU is required (Section 2.5).

## **2.5 Retest After Repair/Adjustment**

After any repair, adjustment or modification that could affect the performance of the instrument, it may be necessary to repeat some of the TBFU or Type tests. The degree of testing depends on the nature of the change. Certain changes may be so fundamental that the some parts of the Type Test should be repeated, for example replacement with a detector from an alternative manufacturer.

## **2.6 Analysis of Test Results**

The results of the TBFU and Periodic Tests of an instrument should be compared with the Type Test data to confirm that the instrument still conforms to type and remains fit for use.

A full record of test results including details of any adjustments made to the instrument should be kept. Current Test results should be compared with previous results and any significant changes noted and investigated, even if all the results fall within specification. For example, the performance of an instrument should be

regarded as suspect if a previously consistent response is now significantly different, even if it is still within acceptable limits.

Whenever an instrument is adjusted during the course of a Periodic Test or TBFU, a statement indicating the nature and magnitude of the adjustment should be made on the test report or calibration certificate.

An instrument will fail the TBFU or Periodic Tests if the results of any component of the appropriate tests are not within the acceptable limits defined in Table 2, Table 3 and Table 4, or if the instrument's performance is deemed unsatisfactory by the Employer.

**Table 1: Summary Of Tests Before First Use And Periodic Tests**

INSTRUMENT	TESTS BEFORE FIRST USE	PERIODIC TESTS
<b>Air Samplers</b>	Parameter Check Pump Test Flow Rate Accuracy Leakage Low Flow Alarm Low Differential Pressure Alarm	Parameter Check Pump Test Flow Rate Accuracy  Low Flow Alarm Low Differential Pressure Alarm
<b>Air Monitors</b>	Parameter Check Pump Test Flow Rate Accuracy Leakage Low Flow Alarm Low Differential Pressure Alarm Response Test Background Activity Alarm Test Detection Efficiency Energy Response Cross Response Gamma Compensation Over Range Test	Parameter Check Pump Test Flow Rate Accuracy  Low Flow Alarm Low Differential Pressure Alarm Response Test Background Activity Alarm Test Detection Efficiency
<b>Laboratory Counting Equipment</b>	Parameter Check Response Test Background Activity Alarm Test Detection Efficiency Energy Response Cross Response Linearity of Response - Activity	Parameter Check Response Test Background Activity Alarm Test Detection Efficiency

## **3 INSTRUMENTS**

### **3.1 Displays**

### **3.2 Airborne Particulate Samplers**

### **3.3 Airborne Particulate monitors**

### **3.4 Laboratory Counting Equipment**

**Table 2: Tests Required for Air Samplers and Air Monitors**

TEST REQUIRED	COMMENTS	PASS/FAIL CRITERIA	TEST BEFORE FIRST USE	PERIODIC TEST	DETAILED REFERENCE
PARAMETER CHECK Check that all accessible parameter settings are correct.			Yes	Yes	
PUMP TEST Confirm the flow rate under minimum and maximum load conditions.	This check is to demonstrate the pump is adequate for purpose.	Acceptable limits to be decided by user.	Yes	Yes	4.1
FLOW RATE ACCURACY: Check the flow rate over the range encountered.	If variations of >20 % from true value then investigations should be carried out.	Failure if > 20 % away from true value.	Yes	Yes	4.2
LEAKAGE This test should be undertaken by the manufacturer.			Yes	No	4.3
FAULT ALARM CHECK: LOW FLOW Activate by manually reducing the flow rate. LOW DIFFERENTIAL PRESSURE Check the alarm is activated by removing the filter material.	Alarm not present on all instruments.		Yes Yes	Yes Yes	4.4.1 4.4.2

**Table 3: Further Tests Required for Air Monitors**

TEST REQUIRED	COMMENTS	PASS/FAIL CRITERIA	TEST BEFORE FIRST USE	PERIODIC TEST	DETAILED REFERENCE
<b>RESPONSE TEST</b> Check that the instrument gives the correct response to source.	This confirms that the reading of the instrument or time to alarm is as expected.		Yes	Yes	5.1
<b>BACKGROUND</b> Measure the background with no air flowing and with a clean filter.			Yes	Yes	5.2
<b>ACTIVITY ALARM TEST</b> Activate the alarm with a source in excess of the alarm threshold.		Confirm correct operation of all alarm functions.	Yes	Yes	5.3
<b>DETECTION EFFICIENCY</b> Use suitable alpha or beta sources as recommended by the manufacturer.	Use a source the same size as recommended by the manufacturer.	Within 20 % of the value recommended by the manufacturer.	Yes	Yes	5.4
<b>ENERGY RESPONSE</b> To cover energies encountered in the workplace.			Yes	No	5.5
<b>CROSS RESPONSE</b> Check that high energy beta-emitters do not produce a significant response in the alpha channel.	Not required for uranium only monitors. Check the response of beta monitors fitted with Geiger counters to alpha emitters		Yes	No	5.6
<b>GAMMA COMPENSATION TEST</b> Measure the sensitivity of both detectors to a known dose rate of gamma radiation in a reproducible geometry.	For beta monitors only. See detailed reference regarding positioning of detectors and source of gamma radiation.	Should be within 30 % of reference data.	Yes	No	5.7
<b>OVER RANGE TEST</b> An over range test should be made as advised by the manufacturer.	Only for Geiger based monitors.	Compare with manufacturer's specifications.	Yes	No	5.8

**Table 4: Tests Required for Laboratory Counting Equipment**

TEST REQUIRED	COMMENTS	PASS/FAIL CRITERIA	TEST BEFORE FIRST USE	PERIODIC TEST	DETAILED REFERENCE
PARAMETER CHECK Check that all accessible parameter settings are correct.			Yes	Yes	
RESPONSE TEST Check that the instrument gives the correct response to source.	This confirms that the reading of the instrument or time to alarm is as expected.		Yes	Yes	5.1
BACKGROUND Measure the background in count mode.	This is dependent on the local environment.		Yes	Yes	5.2
ACTIVITY ALARM TEST Activate the alarm with a source in excess of the alarm threshold.	Confirm correct operation of all alarm functions.		Yes	Yes	5.3
DETECTION EFFICIENCY Use sources as recommended by the manufacturer.	Use a source the same size as the sample area and same distance from detector or else apply a suitable correction.		Yes	Yes	5.4
ENERGY RESPONSE To cover energies encountered in the workplace.			Yes	No	5.5
CROSS RESPONSE Check that high energy beta-emitters do not produce a significant response in the alpha channel.	Not required for uranium only monitors. Check the response of beta monitors fitted with Geiger counters to alpha emitters		Yes	No	5.6
LINEARITY OF RESPONSE - ACTIVITY: Use at least two contamination sources.	This is not practicable for alpha detectors. Sources should be of identical construction and should cover the range of activities which may be reasonably encountered.	The response should not differ by > 30 % from type test data.	Yes	No	5.9

## **4 Specific Tests on the Air Circuit of Air Samplers and Air Monitors**

### **4.1 Pump Test**

### **4.2 Flow Rate Accuracy**

### **4.3 Leakage**

### **4.4 Fault Alarm Check**

#### **4.4.1 Low flow**

#### **4.4.2 Low differential pressure**

## **5 Specific Tests on the Radiation Detection Assembly for Air Monitors and Laboratory Counting Equipment**

- 5.1 Response Test**
- 5.2 Background**
- 5.3 Activity Alarm Test**
- 5.4 Detection Efficiency**
- 5.5 Energy Response**
- 5.6 Cross Response**
- 5.7 Gamma Compensation Test**
- 5.8 Over Range Test**
- 5.9 Linearity of Response - Activity**



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