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HKIAS Supplementary Criteria No. 4

Indoor Air Quality Inspection

1 Introduction

1.1 This document serves to clarify and supplement the requirements of HKAS 002, HKIAS 003 and other relevant HKAS and HKIAS Supplementary Criteria documents for the accreditation of on-site inspection, measurement and sampling activities performed by Indoor Air Quality Certificate Issuing Bodies (CIBs) under the ‘Indoor Air Quality Certification Scheme for Offices and Public Places’ (hereunder called the Scheme, including both its 2003 and 2019 versions). The Scheme is administered by Environmental Protection Department of the Hong Kong SAR Government. It includes assessing the compliance with the indoor air quality (IAQ) objectives for the parameters as set out in the respective version of the Scheme through on-site inspection, monitoring and sampling using specified methods. The accreditation also covers the assessment of the inspection and monitoring results of the IAQ parameters against the requirements stated in the respective version of the Scheme as promulgated in the corresponding version of ‘A Guide on IAQ Certification Scheme for Offices and Public Places’ (hereunder called ‘IAQ Certification Guide’) issued by the IAQ Management Group of the HKSAR Government.

For avoidance of doubt, it should be pointed out that this document only sets out the requirements for accreditation of CIBs under the HKIAS and does not modify the Scheme in any way.

Unless otherwise specified, the criteria set out in this document are applicable to both 2003 and 2019 versions of the Scheme.

1.2 The reassessment and surveillance visit intervals stated in HKIAS Supplementary Criteria No. 5 shall be followed. HKAS may vary the frequency of such visits to an individual accredited inspection body, where necessary.

1.3 On-site measurement may be performed for monitoring most parameters using equipment of the required accuracy (see Clause 4 below). If on-site measurement is not suitable as the required accuracy cannot be achieved, the CIB is required to collect samples on-site and send those samples for laboratory testing. Laboratories performing such tests shall be accredited by HKAS under the Hong Kong Laboratory Accreditation Scheme (HOKLAS) or by a mutual recognition arrangement partner of HKAS. Such parameters may include, e.g.,

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concentration of individual volatile organic compounds (VOCs) (if the results are used for assessing compliance with the corresponding IAQ objectives under the Scheme), formaldehyde, nitrogen dioxide and airborne bacteria.

- 1.4 HKAS will accept an application for HKIAS accreditation from a CIB only if the CIB covers all the IAQ parameters as set out in the respective version of the Scheme. Accreditation will only be granted to the CIB after it has provided sufficient evidence to demonstrate its competence in performing the activities specified in the Scheme including on-site walkthrough inspection, measurement and sampling as well as compliance assessment for all the parameters against the criteria stated in the respective version of the Scheme.

2 TERMS AND DEFINITIONS

- 2.1 The term 'shall' is used throughout this document to indicate those provisions which are mandatory. The term 'should' is used to indicate guidance which, although not mandatory, is provided by HKAS as a recognised means of meeting the requirements.

3 PERSONNEL (HKIAS 003 Clause 6.1)

- 3.1 IAQ inspectors performing on-site measurements and sampling shall satisfy the requirements stated in HKIAS 003, and must have undergone and have been qualified through a documented training and authorisation system. They shall have obtained as a minimum a higher certificate/associate degree/diploma in an engineering, technology, environmental or science discipline issued by a recognised technical institute, or equivalent.
- 3.2 HKIAS operates an **approved IAQ inspector** system for IAQ inspection. Nominees assessed by the HKAS assessors to be competent will be accepted as an approved IAQ inspector. The minimum academic qualifications for nominees are the same as those stated in 3.1 above and they shall have a minimum of one year relevant IAQ experience. As approvals for IAQ inspectors are granted in the context of the IAQ inspection being performed under the relevant management system of an accredited CIB, they are not to be considered as personal qualifications.
- 3.3 HKAS operates an **approved IAQ signatory** system. Nominees satisfying the requirement in 3.4 and assessed by the HKAS assessors to be competent will be accepted as an approved IAQ signatory. An approved signatory is authorised for signing HKIAS endorsed IAQ inspection reports. As approvals are granted

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in the context of the IAQ inspection being performed under the relevant management system of an accredited CIB, they are not to be considered as personal qualifications.

3.4 Nominees for signatory approval for signing HKIAS endorsed IAQ inspection reports shall have:

3.4.1 been qualified as a Registered Professional Engineer (RPE) under the Engineers Registration Ordinance (Cap. 409) and with relevant working experience related to IAQ* since obtaining the qualification; or

3.4.2 been qualified as an Authorised Person within the meaning of the Building Ordinance (Cap. 123) or a public officer certified in writing by his Head of Department as having a qualification and experience which is equally acceptable and not less than 12 months relevant working experience related to IAQ* since obtaining the qualification; or

3.4.3 a master degree in engineering, architecture and environmental or other relevant qualification from a university in Hong Kong, or equivalent, and not less than 24 months relevant working experience related to IAQ* since obtaining the qualification

Note (*) : relevant working experience includes IAQ assessment, monitoring, research, teaching, mechanical ventilation and air conditioning (MVAC) system / heating, ventilation and air conditioning (HVAC) design and management.

To obtain signatory approval, a nominee shall be able to demonstrate to the satisfaction of the assessment team that he/she possesses:

- (i) the same qualification, experience and training that an IAQ supervisor is expected to have as detailed in 3.11 below;
- (ii) knowledge on assessing mould growth in indoor environment, including the principle of mould growth in buildings, techniques in mould inspection, prevention and control of mould growth in indoor environment. Assessing mould growth in indoor environment involves a wide range of knowledge in different disciplines, including microbiology, construction materials, MVAC system, etc. Persons assessing mould growth in indoor environment shall possess adequate knowledge in biological properties and growth of mould in indoor air environment. A person who has attended and successfully completed a relevant professional training course provided by a recognized training provider and passed its written examination could be considered eligible to support indoor mould inspection. Notwithstanding the completion of the training course, competence of a person in indoor mould

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inspection shall be assessed by qualified personnel and appraised to be competent before he or she is allowed to carry out indoor mould inspection independently [applicable to 2019 version of the Scheme only];

- (iii) competence in conducting the walkthrough inspection (including mould inspection for 2019 version of the Scheme) as specified in the respective version of the Scheme. Only approved IAQ signatories are eligible to conduct walkthrough inspection;
- (iv) competence in assessing compliance with the IAQ objectives of the respective version of the Scheme.

Other requirements for approved signatories are detailed 7.4.I of HKIAS 003

3.5 Each IAQ inspector shall undergo a structured training program covering at least the following aspects:

- a. Principle and practice of IAQ monitoring, including measurement and sampling processes and acceptance criteria of the Scheme;
- b. Interpretation of monitoring and measurement requirements and standards;
- c. Factors affecting IAQ;
- d. Obtaining cooperation and support from management and staff of the place to be inspected;
- e. Various IAQ measurement and sampling methods and procedures, their application and limitation, e.g., detection limit, and their selection;
- f. Procedure for walkthrough inspection as specified in the IAQ Certification Guide, method to obtain information from the management of the premises to be inspected and records to be kept, and how such information should be used for determining how measurement and sampling are to be performed;
- g. Procedure for checking the operation of the premises against the documented specifications set by the management of the premises, e.g., those in relation to air exchange rate, frequency and effectiveness of airducts and venetian blinds cleaning and other factors as mentioned in the IAQ Certification Guide, and recording of the findings and any abnormality;
- h. Selection of the locations and timings of taking measurements or samples, including using the information obtained from the walkthrough inspection and how such locations and timings affect the overall monitoring results;
- i. Principle of sampling, including statistical techniques and set up of a sampling plan based on relevant information;
- j. Identification of samples and sub-samples and importance of sample identification;
- k. Preservation of samples and environmental condition requirements for sampling;
- l. Principle and operation of relevant measurement and sampling equipment,

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- including automatic ones. On-site verification of correct functioning of equipment and recording of verification results. The criteria for selection of equipment, including accuracy requirements for a given IAQ parameter;
- m. Factors affecting the accuracy of monitoring and measurement results, including those related to the sampling and monitoring method, sampling and monitoring equipment, their calibration and traceability, and competence of the operator;
 - n. Recording and checking of the measurement details and results, including the conditions of the place during monitoring, e.g., the number of persons inside, the activities being carried out, settings of any mechanical ventilation and air-conditioning system; and
 - o. Drawing conclusion based on monitoring and measurement results.

Emphasis shall be given to:

- (i) Requirements of the management system;
 - (ii) Technical and other requirements of the IAQ Certification Guide;
 - (iii) Expected standards of conduct and ethics;
 - (iv) Rationale and practice of keeping information confidential;
 - (v) The quality assurance plan employed by the CIB to assure the quality of results; and
 - (vi) The importance of adhering to documented quality and technical procedures.
- 3.6 Training shall be provided by people having the required knowledge and capability either within the CIB or from an external party. After training, the competence of the trainees shall be assessed by qualified personnel. Only IAQ inspectors appraised to be competent shall be allowed to carry out measurement and sampling work independently.
- 3.7 Where an IAQ inspector is required to carry out new measurement and sampling methods or use new IAQ measurement and sampling procedures or equipment, appropriate prior training shall also be provided.
- 3.8 Appropriate training shall also be provided to staff members conducting other technical and administrative work.
- 3.9 The training system, the training provided and records of trainee appraisal shall be documented and kept properly for future inspection.
- 3.10 It is useful to keep a competence log listing which IAQ inspectors are competent to perform which parameters of IAQ monitoring, measurements and sampling. Supervisors may assign IAQ jobs to suitable IAQ inspectors according to this log.

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3.11 The performance of all IAQ inspectors, including on-site performance shall be properly supervised. A supervisor supervising the work of IAQ inspectors shall have at least the same qualification, working experience and training as an HKIAS approved IAQ inspector. Where on-site supervision is impracticable, the CIB shall establish and implement an effective feedback system to monitor the conduct and performance of IAQ inspectors.

4 FACILITIES AND EQUIPMENT (HKIAS 003 Clause 6.2)

4.1 For equipment having significant effect on the IAQ measurement or sampling results, the CIB shall use those under its long term control to perform the IAQ measurement and sampling. Appendix A sets out the calibration/verification requirement for most of the necessary equipment for the on-site IAQ measurement and sampling. Where this is impracticable, equipment not under its control may be used.

4.2 The equipment for on-site work shall be verified before or after use unless there is evidence to confirm that such verification is not necessary. For example, the flow rate of a sampling pump shall be checked with a calibrated flowmeter at each use to ensure its proper function, in accordance with instructions given by the manufacturer. Records of verification shall be kept, standard verification procedures shall be provided and the inspectors shall be trained to conduct such verification checks. Where necessary, the inspectors shall also be provided with the necessary reference standards or equipment to conduct the verification checks. For equipment not under the long term control of the CIB, for example, equipment provided by the management of the premises, the inspector shall verify that the equipment is suitable for the purpose, including its measurement range, accuracy, calibration traceability and that the equipment is functioning properly before it is used. Records of such verification shall be kept.

4.3 When electronic means are used for the processing, storage and transfer of information, the systems shall satisfy the requirements of HKIAS 003 and this Supplementary Criteria. Particular attention shall be paid to the validation of software, safety and security of information, maintenance of confidentiality and identity authentication.

4.4 Unless otherwise stated in the relevant standards or IAQ Certification Guide, the uncertainty of any measuring devices should be less than 10% of the value being measured, unless there is evidence to demonstrate that this is not technically possible.

4.5 When it is necessary to evaluate the uncertainty of a measurement, the

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methodology explained in the ISO 'Guide to Expression of Uncertainty in Measurement' (GUM) shall be used.

5 SUBCONTRACTING (HKIAS 003 Clause 6.3)

- 5.1 Whenever an accredited CIB subcontracts any part of the IAQ monitoring, measurement and sampling to another organisation, the subcontractor shall be accredited by HKAS or its MRA partners for performing the activities. Furthermore, results of the subcontracted activities shall be provided in endorsed reports.

6. INSPECTION METHODS AND PROCEDURES (HKIAS 003 Clause 7.1)

- 6.1 CIB shall provide adequate and up-to-date documented work instructions to IAQ inspectors to ensure that all measurements and sampling are performed according to the requirements and acceptance criteria of the IAQ Certification Guide.
- 6.2 The working details of the IAQ inspection should be determined by the supervisor or the Approved Signatory based on the knowledge of the premises in terms of its usage pattern, worst case situations, design of the MVAC system and provisions, and any other findings obtained from the walkthrough inspection, etc. as detailed in the IAQ Certification Guide.
- 6.3 Work instructions provided to IAQ inspectors shall include the following information:-
- a. The address and identification of the premises and the date and time of the monitoring, details of the contact person, the IAQ parameters to be measured and/or sampled, the locations of the measurement and/or sampling points, and any other relevant general information. It may be useful to identify each inspection job with a unique identification number;
 - b. Instruction specific to the given inspection, e.g., the measurement and sampling methods to be used for each measurement or sampling point, the sampling plan, the sample size and equipment to be used, the conditions (including the types of activities being performed inside the premises, the number of people inside the premises, etc.) under which the measurement or sampling is to be performed; and
 - c. General inspection instruction, including recording details of measurement results and samples taken, identification of air samples, equipment operation and verification instructions, instruction on recording of results,

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preservation of samples, etc.

- 6.4 A CIB shall specify the environmental conditions under which IAQ measurement and sampling should be conducted and instruct its inspectors to ensure that such conditions are satisfied during the measurement and sampling process. If measurement and sampling activities must be performed under conditions outside the acceptable ranges, (e.g., insisted by the client) the CIB shall provide instructions to inspectors to ensure that the measurement and sampling are performed under controlled conditions and that such discrepancies are recorded and reported. Any increase in measurement or sampling uncertainty brought about by the compromised environmental conditions shall be taken into account when determining the grading of the premises.
- 6.5 The measurement and sampling points shall be representative of the premises being monitored. Reference to the IAQ Certification Guide is essential.
- 6.6 The CIB shall ensure that proper arrangements and permission for measurement and sampling have been made with the management of the premise prior to performing the on-site work.
- 6.7 Before carrying out on-site activities, the inspector shall brief the responsible person of the premises on the purpose and procedure of the measurement and sampling and solicit his cooperation.
- 6.8 Proforma worksheets, logbooks or electronic recording systems for recording results, details of measurement and sampling procedures, environmental and other conditions affecting the results shall be provided.

7. HANDLING INSPECTION ITEMS AND SAMPLES (HKIAS 003 Clause 7.2)

- 7.1 Air samples obtained on-site shall be uniquely identified to avoid confusion regarding their identity at any time. Details of their origins shall be recorded. It may be useful to assign a unique code to each sample.
- 7.2 A chain-of-custody documentation system should be implemented to keep track of the status of air samples.
- 7.3 Where it is necessary to send air samples to accredited laboratories for testing or retain air samples for reference, the CIB shall ensure that they are adequately identified, properly kept to avoid confusion and deterioration.

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8. INSPECTION RECORDS (HKIAS 003 Clause 7.3)

8.1 Inspection records shall include sufficient information to permit satisfactory evaluation of the inspection. The record system shall permit the ready retrieval of information supporting the results reported to the client. In general, the following items of information shall be kept:

- a. General information on the identity of the premises inspected, including its address and other unique identification;
- b. The identity of the client and any other pertinent information;
- c. Walkthrough floor plan, observations and findings (including those for mould inspection, if applicable);
- d. Details of the measurement and sampling carried out and conditions under which they are carried out, including the IAQ parameters, identifications and locations of the monitoring points, the time of making the measurement or taking the samples, environmental conditions during measurement and sampling;
- e. The identities of the IAQ inspectors;
- f. Condition of the premises during the measurement and sampling. For example, information such as the status and settings of the ventilation system during IAQ measurement and sampling, usage pattern of premises, possible pollution sources such as dusting activities/vacuuming, use of photocopier, etc.;
- g. Identification of the monitoring, measurement and sampling method, including the sampling plan and any deviations from it;
- h. Identifications of the origins of individual samples and sub-samples.
- i. Identification of the acceptance criteria and detection limits of the measurement method used; and
- j. Evidence that the IAQ inspection results have undergone all the necessary quality assurance checks, e.g. the identity and signatory of the checking and reviewing staff member and equipment verification records.

To enable IAQ results evaluation and to demonstrate the validity of the results, more information may have to be recorded. For example, photographs may have to be taken and kept to demonstrate that the sampling locations have been correctly selected or to show details of any observed abnormality.

For record traceability, it may be useful to include the work order number, or an equivalent identification number on every document relating to that inspection.

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9. INSPECTION REPORTS AND INSPECTION CERTIFICATES (HKIAS 003 Clause 7.4)

9.1 Before issuing the final inspection results to the client, the CIB shall ensure that all the inspection results, calculation, data transfer, inspection conclusions and professional judgements have been properly checked. Checks shall confirm the following:

- a. The instructions of the clients have been accurately and comprehensively executed;
- b. Proper measurement and sampling methods have been used;
- c. The measurements and sampling have been performed by qualified IAQ inspectors;
- d. The results have been checked and verified by the supervisor/Approved Signatory;
- e. The equipment used is suitable and properly checked and calibrated;
- f. Samples have been obtained in accordance with the sampling plan under the specified conditions, e.g., the location and size of the sample, environmental conditions, the activities being carried out in the premise at the time of sampling, etc;
- g. Samples and where necessary, sub-samples have been properly identified;
- h. Data transfer and calculations have been correctly made;
- i. The inspection findings have been properly recorded and all records are traceable.
- j. All the necessary data required for arriving at the conclusion, including results obtained from any laboratory or subcontractor, have been obtained;
- k. Observed anomalies have been properly classified;
- l. The conclusions have been properly derived from the monitoring and measurement findings;
- m. Any professional judgements have been properly made in accordance with any guidelines issued by the CIB and the basis of the professional judgement has been clearly recorded; and
- n. Information included in IAQ inspection reports is correct and properly signed by an authorised person, and for endorsed reports, by an Approved Signatory.

9.2 Where it is necessary to issue interim monitoring and measurement results on-site, the results shall be adequately checked, preferably by a staff member of the CIB other than the one performing the inspection. The checker shall sign the inspection record and the interim report to indicate that he has carried out the checks. The interim report shall clearly state that the results are not final and may be amended after reviewing by the CIB. The CIB shall ensure that issuing of such an interim document is allowed by the client and it is given only to the

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person he has designated. The format of the interim report shall be designed to present the results clearly and unambiguously. The CIB shall also ensure that only staff members appraised to be competent to issue interim reports are allowed to do so. They shall also be properly authorised for issuing such reports. Such interim reports shall not bear any HKIAS endorsement.

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APPENDIX A

CALIBRATION/VERIFICATION REQUIREMENT

This Appendix lists the recommended calibration/verification requirements for equipment of on-site IAQ sampling and measurements.

Type of equipment	Recommended maximum period between successive calibration/verification	Calibration/verification procedure or guidance documents and equipment requirements
TEMPERATURE MEASURING DEVICE		
Mercury-in-glass thermometer (MIGT) (May be used for checking electronic thermometers)	5 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003.
	6 months	One-point check at the ice point
Electronic thermometers (Electronic, digital and platinum resistance type)	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003
	Three months, or less if necessary	One-point check against a calibrated MIGT at a temperature within the range in which the instrument is normally used.
Thermocouple or thermistor	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003
	Three months, or less if necessary	One-point check against a calibrated MIGT at a temperature within the range in which the instrument is normally used.

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Type of equipment	Recommended maximum period between successive calibration/verification	Calibration/verification procedure or guidance documents and equipment requirements
RELATIVE HUMIDITY MEASURING DEVICE		
Psychrometer or hygrometer or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003
	Three months, or less if necessary	One-point check against a calibrated hygrometer at a RH value within the range in which the instrument is normally used.
AIR MOVEMENT MEASURING DEVICE		
Hot wire anemometer or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003
	Three months, or less if necessary	One-point check
CARBON DIOXIDE MEASURING DEVICE		
Non dispersive infrared type or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or performed by a body acceptable to HKAS
	Three months, or less if necessary	One-point check using reference gas having proper measurement showing traceability.

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Type of equipment	Recommended maximum period between successive calibration/verification	Calibration/verification procedure or guidance documents and equipment requirements
CARBON MONOXIDE MEASURING DEVICE		
Electro-chemical type or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or performed by a body acceptable to HKAS
	Three months, or less if necessary	One-point check using reference gas having proper measurement showing traceability
RADON MEASURING DEVICE		
Electronic radon monitor or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or performed by a body acceptable to HKAS
FORMALDEHYDE (HCHO) DETECTION		
Formaldehyde detector or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or performed by a body acceptable to HKAS
	Three months, or less if necessary	One-point check using reference gas having proper measurement showing traceability
FORMALDEHYDE (HCHO) SAMPLING DEVICE		
Working air flowmeter for field use or built into pump	Before each use or as recommended by the manufacturer	Check at the applicable flow rate using a calibrated reference flowmeter
Reference flowmeter (e.g. rotameter, anemometer)	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or against a calibrated soap bubble flowmeter (if applicable)

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Type of equipment	Recommended maximum period between successive calibration/verification	Calibration/verification procedure or guidance documents and equipment requirements
NITROGEN DIOXIDE DETECTION		
Chemiluminescence detector equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or performed by a body acceptable to HKAS
	Three months, or less if necessary	One-point check using reference gas having proper measurement showing traceability
Electrochemical type or equivalent	1 year or as per manufacturer's recommendation	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or performed by a body acceptable to HKAS
	Three months, or less if necessary	One-point check using reference gas having proper measurement showing traceability
Direct measurement of absorption (at 450nm) type or equivalent	1 year or as per manufacturer's recommendation	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or performed by a body acceptable to HKAS
	Three months, or less if necessary	One-point check using reference gas having proper measurement showing traceability
OZONE MEASURING DEVICE		
Heated metal oxide electro-chemical type or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or performed by a body acceptable to HKAS
	Three months, or less if necessary	One-point check at a specified point using a UV emitter with certificate of traceability to national or international standards

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Type of equipment	Recommended maximum period between successive calibration/verification	Calibration/verification procedure or guidance documents and equipment requirements
RESPIRABLE SUSPENDED PARTICULATES MEASURING DEVICE		
Light scattering type or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.1 of HKIAS 003 or performed by the equipment manufacturer who can produce a certificate to national or international standards or by a body acceptable to HKAS
	Three months, or less if necessary	One-point check
TOTAL VOLATILE ORGANIC COMPOUNDS MEASURING DEVICE		
Photo-ionisation sensor type or equivalent	2 years	By a 'competent calibration body' as defined in clause 6.2.1 of HKIAS 003 or performed by a body acceptable to HKAS
	Three months, or less if necessary	One-point check using reference gas having proper measurement traceability
INDIVIDUAL VOLATILE ORGANIC COMPOUNDS MEASURING DEVICE		
Working air flowmeter for field use or built into pump	Before each use or as recommended by the manufacturer	Check at the applicable flow rate using a calibrated reference flowmeter
Reference flowmeter (e.g. rotameter, anemometer)	2 years	By a 'competent calibration body' as defined in clause 6.2.1 of HKIAS 003 or against a calibrated soap bubble flowmeter (if applicable)

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Type of equipment	Recommended maximum period between successive calibration/verification	Calibration/verification procedure or guidance documents and equipment requirements
AIRBORNE BACTERIA SAMPLING DEVICE		
Working air flowmeter for field use or built into pump	Before each use or as recommended by the manufacturer	Check at the applicable flow rate using a calibrated reference flowmeter
Reference flowmeter (e.g. rotameter, anemometer)	2 years	By a 'competent calibration body' as defined in clause 6.2.I of HKIAS 003 or against a calibrated soap bubble flowmeter (if applicable)