Hong Kong Association for

Testing, Inspection and Certification Ltd.

Professional Certification Scheme for Testing Personnel

CC07

CERTIFICATION HANDBOOK

CALIBRATION

First Issue
Issued by Hong Kong Association for
Testing, Inspection and Certification Limited

Secretariat: G. P. O. Box 471, Hong Kong

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FOREWORD

The Professional Certification Scheme for Testing Personnel (PCSTP) is a comprehensive scheme which provides examination and certification for individuals seeking to demonstrate their knowledge and/or competence in their field of operation.

The Scheme is developed under HKTIC and managed by the Certification Board (CB), which is responsible for the granting, reviewing and revising the personnel certification titles and requirements in accordance with the prevailing demand of the testing industries served by the Scheme. The Certification Board, in turn, may appoint specialist working committees as it deems necessary to oversee specific parts of the Scheme.

The sole criteria for certification of personnel engaged in calibration are given in this document (and any subsequent amendments) and no other criteria will be applied. Certification is not conditional on the candidate applying for other services or membership from HKTIC or any other groups or associations.

The benefits of certification include:

1. recognition and prestige for the individual and creation of a competitive advantage over non-certified individuals in the same field;
2. enhanced employment opportunities;
3. establishment of a professional standard for individuals in a particular testing field;
4. assistance to employers in making more informed recruitment decisions;
5. a more productive and highly trained workforce for employers;
6. enhanced professional impression on customers;
7. assistance to clients in making informed decisions about qualified providers;
8. protection of the general public from using incompetent and unfit practitioners; and
9. assurance of the general public of the accuracy and validity of testing results.

Requirements of Certification of Personnel Engaged in Calibration

1. General

1.1. This document prescribes procedures by which personnel may be examined and, if successful, certified for calibration.

2. Scope of Certification

2.1. The levels of certification available are

2.1.1. Certified Testing Technician and;

2.1.2. Certified Testing Professional.

3. Eligibility for certification

3.1. Candidates shall have a combination of education, training and experience adequate to ensure that they have the potential to understand the principles and procedures of the applicable methods.

3.2. Academic qualification and experience

3.2.1. Certified Testing Technician (CTT)

(a) The candidate shall have

- a diploma in physical science, engineering, applied science or equivalent with no less than two years of relevant testing experience; or
- 10 years of relevant testing experience; or
- any other qualifications and experience deemed as equivalent.

3.2.2. Certified Testing Professional (CTP) (any one of the requirements (a) to (c)).

(a) The candidate shall have a bachelor's degree in physical science, engineering, applied science or equivalent and with no less than three years of relevant experience, or

(b) Candidate without a degree shall

- have been certified as Certified Testing Technician by the Certification Board and have no less than five years of relevant supervisory experience post certification as CTT, or

- have no less than 15 years of relevant experience of which 5 years shall be at managerial positions, or

(c) Candidates shall have any other qualifications and experience deemed as equivalent.

3.3. Training

3.3.1. Certified Testing Technician

The candidate shall

(a) provide certificates of achievement in training courses (satisfactory results in end-of-course evaluation) approved by the Certification Board in respective competence requirements; or

(b) obtain satisfactory results in PCSTP examinations as arranged by the Certification Board.

Details of approved training courses are available at the website www.hktic.org.

3.3.2. Certified Testing Professionals

Candidate shall

(a) (any one of the following:)

(i) provide certificates of achievement (satisfactory results in end-of-course evaluation) in training courses approved by the Certification Board in respective competence requirements; or

(ii) obtain satisfactory results in PCSTP examinations as arranged by the Certification Board; or

(iii) have no less than 15 years of relevant experience, of which 5 years shall be at managerial position; or

(iv) be a HOKLAS approved signatory with not less than 8 years of relevant experience and the scope of signatory approval covering the major measurement techniques or methods as stipulated in this Certification Handbook for the sub-category the certification is being sought; and

(b) obtain satisfactory results in professional assessment by interview.

Details of approved training courses are available at the website www.hktic.org.

3.4. Competence requirements for Certified Testing Technician

3.4.1. General requirements

- Understanding of ISO/IEC 17025 including quality control requirements
- Laboratory safety
- Integrity management

3.4.2. Technical requirements

- Understanding basic calibration methods
- Knowledge of equipment usage

3.5. Competence requirements for Certified Testing Professional

3.5.1. Management requirements

- Management skills
- Integrity management

3.5.2. Quality requirements

- Laboratory management in compliance with ISO/IEC 17025 including
  - Statistical treatments of data and quality control requirement
- Laboratory safety

3.5.3. Technical requirements

- Estimations of measurement uncertainty
- Interpretation of results and reporting requirements
- Requirements of traceability and calibration of reference standards
- Principles of measurement methods employed in calibration

4. Examination Procedure

4.1. A candidate who can provide certificates of achievement in training courses in all competence requirements may be exempted from PCSTP examinations.

4.2. Partial exemption for PCSTP examinations is not allowed.

4.3. No exemption is permitted for professional assessment by interview for Certified Testing Professional candidates.

4.4. Examinations consist of

4.4.1. Written examination; and/or

4.4.2. Professional assessment by interview (for Certified Testing Professionals only).

4.5. Candidates must satisfy the examiner(s) in all parts. Details of the examination format follow the syllabus and specimen examination questions as given in Appendices 1 and 2 respectively.

4.6. Types of questions

4.6.1. Multiple choice questions

4.6.2. Short answer questions

4.6.3. Open-ended questions

4.7. Examination for Certified Testing Technician

4.7.1. The examination will cover both general and technical requirements.

4.7.2. Questions will comprise only of multiple choice and short answer questions.

4.7.3. Time length of examination

- Written examination – 2 hours

4.7.4. Weighting of each topic

	Topics	Weight (%)
a)	Understanding ISO/IEC 17025 and quality control	14
b)	Laboratory safety	10
c)	Integrity management	10
d)	Understanding calibration methods and techniques	40
e)	Equipment usage	26

The weight of each topic shall not deviate from the pre-set percentage by more than 5%.

4.7.5. Marking system

- Model answer shall be set for each multiple choice questions. Marks will be given for correct answers.

- Suggested answers shall be set and marks should be allocated according to key points of answers for short questions. Marks for each key point should be pre-set. Marks would be given to answers with meanings which match the suggested answers as judged by the marker.

4.7.6. Passing mark

- The passing mark for each section shall typically not be less than 40% and the typical overall passing mark is 60% for the written examination.

4.8. Examination for Certified Testing Professional

The examination will comprise written examination and professional interview.

4.8.1. Written examination will cover the following:

- Management requirements
- Quality requirements
- Technical requirements

4.8.2. Professional assessment by interview

- The interview will cover all certification criteria and focus on underlying principles, limitations, quality control checks and reporting requirements of tests currently undertaken by the candidate.

4.8.3. Time length of examinations

- Written examination – 3 hours
- Professional assessment by interview – 30 to 50 minutes

4.8.4. Weighting for each topic

	Topics	Weight (%)
a)	Management requirements	10
b)	Integrity management	5
c)	Laboratory management in compliance with ISO/IEC 17025	20
d)	Laboratory safety	5
e)	Estimation of measurement uncertainty	20
f)	Interpretation of results and reporting requirements	10
g)	Principles of calibration methods and requirements of equipment	30

The weight of each topic shall not deviate from the pre-set percentage by more than 5%.

4.8.5. Marking system

- The same marking system as Section 4.7.5 shall apply. The marking system for open-ended questions shall be the same as that for short questions.

4.8.6. Passing Mark

- The passing mark for each section shall typically not be less than 40% and the typical overall passing mark is 60% for the written examination.

- A candidate must pass both the written examination and the interview.

5. Application Procedure for Certification/Examination and Fees

5.1. Application form

5.1.1. Applications must be made on line at www.hktic.org.

5.1.2. The application form asks for specific details of experience and training and must be signed confirming that these details are accurate and supported by such other documents as may be necessary to confirm that the candidate is eligible for examination. Filled and signed application form together with supporting documents should be sent to Programme Secretariat by post. Any submitted application and documents become the property of HKTIC and shall not be returned.

5.1.3. The examination dates for applications can only be confirmed after receipt of a properly completed application form and the full fees. In the event of false statements being discovered, any certificate awarded will be revoked and declared null and void.

5.2. Application and examination fees

5.2.1. The fee structure is as follows:

Level	Type of application/examination	Fee (HK$)
CTT	Initial and upgrade application	$300
	Examination (written), if applicable [Note]	$500
	Annual subscription fee	$500
CTP	Initial and upgrade application	$500
	Examination (written), if applicable [Note]	$500
	Examination (professional assessment)	$1,000
	Annual subscription fee	$500

Note:
Written examination can be exempted under the following conditions by:

a. achieving certificates of achievement (satisfactory results in end-of-course evaluation) in approved training courses for all competence requirements; or

b. fulfilling the academic requirements and having no less than 15 years of relevant experience, of which 5 years shall be at a managerial position for testing professionals.

5.3. Initial certification, certification upgrade and extension of certification of new category

5.3.1. Candidates who are seeking certification for the first time or for those wishing to upgrade or extend their certification credentials can submit their application on line at www.hktic.org.and download the Handbook for the category to be certified.

5.3.2. The candidate shall submit payment, the completed application form and documentation consisting of :

- Academic qualifications;
- Certificates of achievements in appropriate training courses; and
- Any other relevant records

5.3.3. The application is reviewed and evaluated by the Programme Officer for confirmation of acceptance at the requested level of certification. The candidate is notified of the decision and/or date and time of examination where applicable.

5.3.4. The Certification Board may grant certification to Testing Technicians directly without examination on condition that they fulfil the academic and training criteria as stipulated in clauses 3.2.1 and 3.3.1.

5.3.5. The Certification Board may recommend that a candidate seeks certification at an alternate level, or terminate the certification process after reviewing the documents submitted. The application fee would not be refunded.

5.3.6. The examiners involved are independent and do not respond to questions from the candidate. The Programme Officer provides the information about the certification process to the candidate and answers questions he/she may have.

5.3.7. The Certification Board makes the decisions on awarding a pass or fail based primarily upon the recommendation of the examiners.

5.3.8. A candidate applying for Certified Testing Professional is advised to take and pass the written examination before applying for professional assessment by interview.

5.3.9. All certified personnel will be registered in databases and presented as public information on their respective websites. The candidate is notified of the result of the

certification procedure within 30 calendar days after the examination or submission of application. They are entitled to use the designation Certified Testing Technician or Certified Testing Professional, or the abbreviations CTT or CTP as awarded.

5.4. Re-certification

5.4.1. Certified personnel are required to be re-certified after the period of certification validity, which is normally 3 years from the date of issue of the certificate, has expired.

5.4.2. The re-certification process is different from the first certification process. It concentrates on the continuing professional development (CPD) of the individual that has taken part in since the last certification or re-certification. Similar to first certification, certified personnel shall visit the website and download the application form and shall submit payment and completed documentation, consisting of

- Application form for re-certification
- Working experience in the past 3 years and
- Records of Continuing Professional Development (form for recording of CPDU is available at the website www.hktic.org)

5.4.3. The Programme Secretariat will review the records of CPD to determine whether the re-certification candidate fulfils the CPD requirements for his/her level.

5.5. Continuing Professional Development (CPD)

5.5.1. The Continuing Professional Development programme supports the ongoing educational and professional development of individuals who have attained certification. The purpose of the CPD program is to:

- enhance ongoing professional development;
- encourage and recognize individualized learning opportunities;
- maintain the value and recognition of the certification; and
- provide a vehicle for attaining and recording professional development activities.

5.5.2. In order to satisfy the CPD programme and maintain an active certification status, certified personnel must accrue and report a minimum of 30 and 60 Continuing Professional Development Units (CPDUs) during each three-year certification cycle for Certified Testing Technician and Certified Testing Professional respectively. A

Certified Testing Technician can accrue the necessary CPDUs by participating in any one or more activities as listed in PCSTP07. A Certified Testing Professional shall participate in at least two activities. The number of CPDUs accrued for one activity shall not be less than 30 in case the Professional attends only two activities. The expiry date of validity is shown on the certificate.

5.5.3. Continuing Professional Development Units (CPDUs)

- The Continuing Professional Development Units (CPDUs) is the measuring unit used to quantify approved learning and professional service activities. Typically, one CPDU is earned for every one hour spent in a planned, structured learning experience or activity. There is a range of opportunities available to certified personnel to acquire CPDUs through training/education programmes and professional activities covering seminar, industrial discussion group, symposium, training course, etc. PCSTP07 gives guidelines for counting CPDUs.

5.6. Cancellations, Rescheduling, No Shows

5.6.1. If a candidate needs to cancel or reschedule an interview or an examination, he/she must do so no later than 2 working days before the scheduled appointment.

5.6.2. If he/she fails to notify the Programme Secretariat within the specified time period and/or fails to meet a scheduled examination appointment, he/she forfeits the full certification fee and will have to pay the full certification fee in order to schedule another interview or examination.

5.6.3. There are times when extenuating circumstances (e.g. medical emergency, death in immediate family, illness in immediate family) may prevent a candidate from meeting a scheduled interview or examination appointment, resulting in a no show. Should such a situation arise, the candidate must provide explanations along with supporting documentation (e.g. accident report, medical documentation, death certificate) and request to be rescheduled. If he/she does not make contact with the Programme Secretariat within 3 working days following a missed appointment, another fee shall be paid in order to schedule a new appointment. Each request will be reviewed on a case-by-case basis. The candidate is allowed a maximum of one year, from the date of application is approved, to apply for re-examination.

6. Appeal

6.1. As a policy, the Certification Board has a procedure for considering appeals against its decision at the end of each stage of the certification cycle.

6.2. Written examination recheck

6.2.1. The marks awarded for a particular section may be subject to a recheck. A recheck is carried out to ensure that there have been no arithmetical or clerical errors, that the marks awarded are appropriate and that all the marks to which the candidate is entitled have been included in the final total.

6.3. Professional assessment Review

6.3.1. The grounds for such review must clearly identify the element or elements of the assessment for which the review is sought. It must also specify the grounds on which the review is sought and must contain all information, which the candidate requests to be taken into account in the review.

6.3.2. The grounds for a review are:

- the regulations have not been properly implemented.
- the regulations do not adequately cover the candidate's case.
- compassionate or medical circumstances related to the candidate's assessment situation, which were made known by the candidate in writing.
- significant performance related information which the candidate believes was not considered by the examiners.

6.4. Appeal for a written examination recheck

6.4.1. A request for a recheck must be received no later than 10 working days after the date of posting of the examination results.

6.4.2. Only a written request for a recheck will be considered.

6.4.3. A fee, as stipulated in the Schedule of Fees, will be charged, which must be included in the request for a recheck. Such fee is non-refundable.

6.5. Appeal for a professional assessment review

6.5.1. A request for a review must be received no later than 10 working days after the date of posting of the assessment results.

6.5.2. Only written requests will be considered.

6.5.3. As the result of the appeal needs to be ratified by the Certification Board, it may take some time before the candidate is notified of the decision.

6.5.4. The fee for the professional assessment review is as set forth in the Schedule of Fees. Such fee is non-refundable.

6.6. An appeal form for appeal of written examination and professional assessment is available at the website www.hktic.org.

7. Obligations

7.1. A certified personnel shall at all times:-

7.1.1. commit to abide with the Regulations as set for the Professional Certification Scheme for Testing Personnel;

7.1.2. pay the fees and charges as determined by the Certification Board;

7.1.3. represent honestly and truthfully to any person concerned that he/she is only certified for activities stated in the scope of certification;

7.1.4. endeavour to ensure that the certification granted by the Certification Board is not used in a misleading manner; and

7.1.5. maintain complete integrity and impartiality in all circumstances.

7.2. Details of the Regulations are given in the document PCSTP01 “Regulations for Professional Certification Scheme for Testing Personnel”.

APPENDIX 1:

Examination syllabus and specimen questions for Certified Testing Technician

Any aspect of the syllabus may be included in the written examinations or professional assessments. The level of knowledge required by the candidates varies according to the topic. To ensure comprehension by all parties, the following terms have been selected to demonstrate an increasing level of knowledge.

Definitions

Outline Knowledge: The candidate must be familiar with the subject in outline terms. He/She should know that the topic exists and what it is applied to. In the context of methods/techniques the candidate would be expected to know "what it is, what it does" but would not be expected to know the finer points of application of the technique.

Knowledge: The candidate must have a working knowledge of the subject and be able to apply it.

Detailed Knowledge: The candidate must have a depth of knowledge sufficient to enable him/her to exercise judgment.

Types of questions

For all multiple-choice questions candidates are required to tick or otherwise indicate the correct answer in the space provided.

Candidates are expected to give a few words, a phrase or a sentence as answers for short answer questions in the space provided.

Candidates are required to explain in depth for open-ended questions.

1. Examination syllabus of Certified Testing Technician

1.1. General requirements (outline knowledge)

1.1.1. Understanding of ISO/IEC 17025

- Document control
- Technical records
- Environmental and calibration conditions

- Equipment
- Traceability, use and handling of reference standards
- Sample handling such as storage conditions, etc.

1.1.2. Laboratory safety (knowledge)

- General laboratory safety
- Safety in calibration laboratories
- Proper handling of heavy duty samples or large equipment
- Use of fire extinguisher

1.1.3. Integrity management (detailed knowledge)

- Prevention of Bribery Ordinance, Cap. 201
  - Corruption
  - Advantages
- Confidentiality and proprietary right
- Outside Employment
- Use of company assets
- Conflict of Interest
- PCSTP01 "Regulations – Professional Certification Scheme of Testing Personnel"
  - Code of ethics in general
  - Code of ethics in relation to employer
  - Code of ethics in relation to public
  - Obligation of Certified Testing Personnel
  - Use of PCSTP symbol and claim of certification status

1.2. Technical requirements (knowledge)

1.2.1. Understanding on the measurement techniques, related precautions, limitations and mal-practice for at least three of the calibration parameters as stipulated in Appendix 4

1.2.2. Knowledge on the use and daily check requirements of equipment used for performing the calibration.

2. Specimen examination questions

2.1. What are the parameters to be evaluated for calibration of balances. State the precautions in performing the calibration.

2.2. Name two pieces of information that must be identified on a calibration label.

2.3. According to the Prevention of Bribery Ordinance, name 2 things that are considered as advantages.

APPENDIX 2:

Examination syllabus and specimen questions for Certified Testing Professional

1. Competence requirements of Certified Testing Professional

1.1. Management requirements (Detailed knowledge)

1.1.1. Manager's basic functions

1.1.2. Time management

1.1.3. Communication in your workplace

1.1.4. Team Building – basic understanding of concepts

1.1.5. Delegation and management of Generation Y

1.2. Quality requirements

1.2.1. Laboratory Management in compliance with ISO/IEC 17025 (Detailed knowledge in the following aspects)

- Document control
- Review of contract
- Subcontracting
- Difference between correction and corrective actions and control of non-conforming work
- Preventive actions
- Technical records
- Laboratory layout in segregation of activities and prevention of contamination
- Traceability
- Sample identification and integrity within laboratory
- Quality assurance procedures and plan
  - Method verification (detailed knowledge)
    - Minimum method verification in complying with specification of test standards
    - Difference between verification and validation
    - Participation in proficiency testing programme, interlaboratory comparison programme
    - Verification of continuing competence
    - Drafting of test procedures
  - Statistical treatments of data (detailed knowledge)
    - Basic statistics such as student-t test, normal distribution, standard deviation and ESDM

1.2.2. Laboratory safety (knowledge)

- General laboratory safety
- Safety in physical testing laboratories
- Safe use of chemical cleaners and solvents
- Proper handling of heavy duty samples or large equipment
- Use of fire extinguisher

1.2.3. Integrity Management (detailed knowledge)

- Prevention of Bribery Ordinance, Cap. 201
  - Corruption
  - Advantages
- Confidentiality and proprietary right
- Outside employment
- Use of company assets
- Conflict of Interest
- PCSTP01 "Regulations – Professional Certification Scheme of Testing Personnel"
  - Code of ethics in general
  - Code of ethics in relation to employer
  - Code of ethics in relation to public
  - Obligation of Certified Testing Personnel
  - Use of Certification symbol and claim of certification status

1.3. Technical requirements (knowledge)

1.3.1. Estimation of measurement uncertainty

- Approaches : ISO GUM
  - Standard, combined and expanded uncertainty
  - Sensitivity coefficient
  - Degrees of freedom
- Factors affecting uncertainty
- Reporting of uncertainty and compliance

1.3.2. Detailed knowledge of the following aspects for at least three of the calibration parameters as stipulated in Appendix 4

- scope, limitations and principles
- selection of methods and reference standards, pros and cons of different techniques
- calibration conditions such as temperature and humidity requirements

- accuracy class and maximum permissible error of the unit under test
- reporting requirements

1.3.3. Detailed knowledge of performance of equipment and reference standards

- linearity – accuracy of response over measurement range
- stability – short and long term (drift)
- response time – how fast it responds
- precision
- resolution
- hysteresis
- calibration and intermediate check requirements
- limitations and applications
- maintenance
- trouble shooting

2. Specimen examination questions

2.1. Define corrective and preventive actions and illustrate their difference with an example.

2.2. Given the following information, evaluate the measurement uncertainty of the calibration.

2.3. What are the parameters to be evaluated for calibration of balances. State the principles in performing the calibration and checks of such parameters.

APPENDIX 3

Training courses approved by the Certification Board

Before 31 December 2013, the candidate attending the courses as listed below is deemed to have satisfied the competence requirements shown.

1. Certified Testing Technician

Competence requirements	Course Name	Training Provider
ISO/IEC 17025	Laboratory management	HKAS/HKTIC/VTC
Laboratory safety	Laboratory safety	HKTIC/VTC/OSHC/Labour Department

2. Certified Testing Professional

Competence requirements	Course Name	Training Provider
ISO/IEC 17025	Laboratory management for organizations implementing ISO/IEC 17025:2005	HKAS/HKTIC/IVE
Laboratory safety	Laboratory safety	HKTIC/VTC/OSHC/ Labour Department
Measurement uncertainty	Guide to expression of uncertainty of measurement (ISO GUM)	HKAS/HKTIC/SPACE

HKTIC – Hong Kong for Testing, Inspection and Certification Limited
HKAS – Hong Kong Accreditation Services
VTC – Vocational training Council
IVE – Hong Kong Institute of Vocation Education
OSHC - Occupational Safety and Health Council

Commencing from 1 January 2014, the candidate is required to obtain certificates of achievement (satisfactory results in end-of-course evaluation) in approved courses in meeting the competence criteria. Lists of training organizations and training courses are available at the Scheme website www.hktic.org.

1. Certified Testing Technician (both quality and technical requirements)

Competence requirements	Course Name	Duration (hours)
Quality requirements	Understanding ISO/IEC 17025 & laboratory safety	7 hours
Technical requirements	Calibration techniques covering at least 3 parameters	12 hours lecture + 12 hours practical
Integrity requirements	Ethics	3 hours

2. Certified Testing Professional

Competence requirements	Course Name	Duration (hours)
Management skills	Comprehensive management	15
ISO/IEC 17025 Statistical treatment of data and quality control requirements	Laboratory management	21
Safety	Laboratory safety	6
Measurement uncertainty	Measurement uncertainty based on ISO GUM	21
Technical requirements	Calibration techniques and principles covering at least 3 parameters	12

APPENDIX 4

Calibration parameters

1 Basic knowledge of the following basic metrological terms
1.1 International System of Units, SI
1.2 Quantity
1.3 Derived unit (of measurement)
1.4 True value, conventional true value
1.5 Measurand
1.6 Measurement
1.7 Influence quantity
1.8 Corrected/uncorrected results
1.9 Accuracy
1.10 Precision
1.11 Resolution
1.12 Repeatability and reproducibility
1.13 Error – random and systematic
1.14 Correction
1.15 Drift
1.16 Response time of measuring instrument
1.17 Primary, reference and working standard

2 Calibration of temperature
2.1 The International Temperature Scale ITS-90
2.2 The fixed points of ITS
2.3 Different types of sensors
2.3.1 liquid-in-glass thermometer
2.3.2 resistance thermometer
2.3.3 thermocouple
2.3.4 bimetallic strip thermometer

2.4 Means of calibration (temperature source)
2.4.1 Baths
2.4.2 Kilns
2.4.3 Climatic chambers
2.4.4 Generator’s

2.5 Calibration methods and typical setup for
2.5.1 liquid-in-glass thermometer
2.5.2 resistance thermometers
2.5.3 thermocouples
2.5.4 infrared thermometer

3 Calibration of Humidity
3.1 Dry and moist air
3.2 Specific and absolute humidity
3.3 Primary standard - Gravimetric hygrometer

3.4 Secondary standards
3.4.1 Chilled mirror hygrometer
3.4.2 Electrolytic hygrometer
3.4.3 Psychrometer
3.4.4 Impedance hygrometer
3.4.5 Polymer RH sensor

3.5 Principles of humidity (for CTP only)
3.5.1 Ideal gas Law
3.5.2 Thermodynamic dew-point and frost point temperature
3.5.3 Relationships between dew-point and frost-point temperature and mixing
3.5.4 Relative humidity to water and ice
3.5.5 Saturation

4 Calibration of balances and mass
4.1 Mass and weight principles
4.2 Weighing instruments and classification
4.3 Classes of standard mass

4.4 Calibration method of mass
4.4.1 Magnetism
4.4.2 Surface roughness
4.4.3 Cleaning
4.4.4 Density
4.4.5 Weighing cycle

4.5 Calibration method and parameters of balance
4.5.1 Linearity
4.5.2 Eccentric
4.5.3 Hysteresis
4.5.4 Repeatability
4.5.5 Scale value check
4.5.6 Classes of standard masses used

5 Calibration of force measuring system
5.1 Unit of measurement
5.2 Force measuring and indicating devices
5.3 Repeatability
5.4 Maximum permissible errors of force indication
5.5 Resolution
5.6 Relative reversibility error
5.7 Assigned accuracy class

5.8 Load cell
5.8.1 Principles of classification
5.8.2 Accuracy classes and mmaximum permissible errors
5.8.3 Permissible variation of results
5.8.4 Repeatability error
5.8.5 Influence quantities
5.8.6 Measurement standards
5.8.7 Additional requirements for load cells equipped with electronic (detail of measurement methods are not required)

6 Calibration of length
6.1 Calibration methods
6.1.1 Unit of measurement
6.1.2 Scale accuracy and large scale linearity
6.1.3 Scale interval accuracy
6.1.4 Scale interval linearity
6.1.5 Accuracy of other metrological components
6.1.6 Accuracy tests for indicating devices
6.1.7 Secondary standards
6.1.8 Influence factors factor for measures with ancillary electronic devices (detail

measurements methods are not required)

6.2 Length measuring devices

6.2.1 Steel tape

6.2.2 Flexible tape measure made of fibreglass and plastics or other suitable non-metallic materials

6.2.3 Micrometer

6.2.4 Vernier caliper

6.2.5 Feeler gauge

6.2.6 Block gauge

6.2.7 Microscope

6.2.8 Lasermetric device

6.2.9 Ultrasonic device

APPENDIX 5

References

1. *ISO/IEC 17025:2005* "General requirements for the competence of testing and calibration laboratories"

2. *HKTIC PCSTP01* "Regulations for Professional Certification Scheme for Testing Personnel"

3. *HKTIC PCSTP07* "Guidelines for Counting Continuing Professional Development Unit (CPDU)"

4. *ISO 5725-3: 1994* Accuracy (trueness and precision) of measurement methods and results Part 3 – Intermediate measure of the precision of a standard measurement method

5. *ISO/IEC 98* :2008 Guide to the Expression of Uncertainty in Measurement

6. *ASTM D2904- 97 (Re-approved 2002)* Standard Practice for Interlaboratory Testing of Textile Test Method that Produces Normally Distribute

7. *HOKLAS Supplementary Criteria No. 2* "All Test Categories – Equipment Calibration and Verification"

8. *GUIDEBOOKS FROM LABOUR DEPARTMENT OF HKSAR*

8.1. A brief guide to first aid
8.2. A brief guide to the Occupational Safety and Health Ordinance
8.3. A brief guide to the Occupational Safety and Health Regulation
8.4. Code of practice on safety management
8.5. Guidelines for good occupational hygiene practice in a workplace
8.6. Hazards during chemicals in use and safety guidelines

9. *Standards in relation to laboratory safety*
9.1. *BS 7258* Laboratory fume cupboards
9.2. *AS 2444* Portable fire extinguishers and fire blankets - Selection and location
9.3. *AS/NZS 2243.8* Fume cupboards

10. *World Metrological Organization Instruments and Observing Methods Report No. 86*

11. *Standards in relation to calibration of weights and balance*

11.1. *NMIA* The Calibration of Weights and Balances

11.2. ASTM E617 - 97(2008) Standard Specification for Laboratory Weights And Precision Mass Standards

11.3. OIML R111-1: 2004 Weights of classes E1, E2, F1, F2, M1, M1-2, M2, M2-3 and M3. Part 1: Metrological and technical requirements

12. *Standards in relation to calibration of force measuring machine*

12.1. BS 1610-1:1992 Materials testing machines and force verification equipment. Specification for the grading of the forces applied by materials testing machines when used in the compression mode

12.2. BS EN 10002-1:2001. Tensile testing of metallic materials. Method of test at ambient temperature

12.3. ISO7500-1: 2004 Metallic materials -- Verification of static uniaxial testing machines -- Part 1: Tension/compression testing machines -- Verification and calibration of the force-measuring system

12.4. ISO7500-2: 2006 Metallic materials -- Verification of static uniaxial testing machines -- Part 2: Tension creep testing machines -- Verification of the applied force

12.5. AS 2193: 2005 Calibration and classification of force-measuring systems

12.6. AS 1349-1986 Bourdon tube pressure and vacuum gauges

12.7. OIML R60: 2000 Metrological regulation for load cells

12.8. OIML R65: 2006 Force measuring system of uniaxial material testing machines

13. *Standards in relation to calibration of length*

13.1. BS 959:2008. Specification for internal micrometers (including stick micrometers)

13.2. BS 870:2008. Specification for external micrometers

13.3. BS 4311-2:2009. Gauge blocks manufactured to imperial specification.

13.4. ISO3650: 1998/Cor-1:2008 Geometrical Product Specifications (GPS) -- Length standards -- Gauge blocks

13.5. ISO3611: 2010 Geometrical product specifications (GPS) -- Dimensional measuring equipment: Micrometers for external measurements -- Design and metrological characteristics

13.6. OIML R 35-1: 2007 Material measures of length for general use. Part 1: Metrological and technical requirements
13.7. OIML R 35-2 : 2011 Material measures of length for general use. Part 2: Test methods

14. *Standards in relation to calibration of thermohygrometer / thermohygrograph*
14.1. AS 2001.1-1995 Methods of test for textiles - Conditioning procedures Appendices C and D

15. *Standards in relation to calibration of temperature*
15.1. ASTM E220 - 07a Standard Test Method for Calibration of Thermocouples By Comparison Techniques
15.2. ASTM E230 - 12 Standard Specification and Temperature Electromotive Force (EMF) Tables for Standardized Thermocouples
15.3. BS 1041-4:1992. Temperature measurement. Guide to the selection and use of thermocouples
15.4. ASTM E77 - 07 Standard Test Method for Inspection and Verification of Thermometers

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