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IAS GUIDE FOR REPRESENTING SCOPES OF ACCREDITATION FOR CALIBRATION LABORATORIES

1. INTRODUCTION AND SCOPE

This document provides IAS guidelines for the representation of a calibration laboratory's scope of accreditation. The scope of accreditation document represents an accreditation body's official declaration of a laboratory's calibration and measurement capabilities (CMC) and attests to the fact that the laboratory has the technical competence to perform the activities listed on this document. It also serves as a means to provide the customer of an accredited calibration laboratory with a clear description of a laboratory's activities covered by their ISO/IEC 17025 accreditation.

The purpose of this guide is to outline the IAS requirements for calibration scopes of accreditation, and to establish guidelines that minimize sources of variability in order to ensure that all IAS scopes of accreditation for calibration laboratories are similar in appearance and display similar levels of detail.

2. DEFINITIONS

BIPM: International Bureau of Weights and Measures. The BIPM is

— the international organization established by the Metre Convention, through which Member States act together on matters related to measurement science and measurement standards
— the home of the International System of Units (SI) and the international reference time scale (UTC)."

(https://www.bipm.org/)

~~Bureau International des Poids et Mesures (BIPM). BIPM is the organization whose task is to ensure world-wide uniformity of measurements and their traceability to the International System of Measurements (SI).~~
~~http://www1.bipm.org/en/home/~~

CALIBRATION AND MEASUREMENT CAPABILITY (CMC): A CMC is a calibration and measurement capability available to customers under normal conditions: (a) as published in the

BIPM key comparison database (KCDB) of the CIPM MRA; or (b) as described in the laboratory's scope of accreditation granted by a signatory to the ILAC Arrangement. *(ILAC-P14:09/2020)*

CGPM: General Conference on Weights and Measures. The CGPM is the primary intergovernmental treaty organization responsible for the SI, representing nearly 50 countries. It has the responsibility of ensuring that the SI is widely disseminated and modifying it as necessary so that it reflects the latest advances in science and technology. *(https://physics.nist.gov/cuu/Units/acronyms.html)*

CIPM: International Committee on Weights and Measures (CIPM)International Committee for Weights and Measures. The CIPM comes under the authority of the CGPM. It suggests modifications to the SI to the CGPM for formal adoption. The CIPM may also on its own authority pass clarifying resolutions and recommendations regarding the SI. *(https://physics.nist.gov/cuu/Units/acronyms.html)*
http://www.bipm.org/en/committees/cipm/
ILAC: The International Laboratory Accreditation Cooperation.
http://www.ilac.org

International System Of UnitsINTERNATIONAL SYSTEM OF UNITS (SI): System of units, based on the International System of Quantities, their names and symbols, including a series of prefixes and their names and symbols, together with rules for their use, adopted by the General Conference of Weights and Measures (CGPM). (*JCGM 200:2012)*.

NIST: National Institute of Standards and Technology, the NMI for the U.S.
http://www.nist.gov

NMI: National Metrology Institute or National Measurement Institute

CMC: a *CMC* is a calibration and measurement capability available to customers under normal conditions: *(a)* as published in the BIPM key comparison database (KCDB) of the CIPM MRA; or *(b)* as described in the laboratory's scope of accreditation granted by a signatory to the ILAC Arrangement.

CIPM: International Committee on Weights and Measures (CIPM)
http://www.bipm.org/en/committees/cipm/

3. GUIDELINES

3.1 All scopes of accreditation for calibration laboratories must comply with the requirements of ILAC--P14, *ILAC Policy for Uncertainty in Calibration.* While this guidance document does not repeat all the ILAC requirements stated in ILAC--P14, all ILAC policies must be observed followed when formulating scopes of accreditation. In addition, this document takes into account the guidance provided in ILAC-G18, *Guideline for describing Scopes of Accreditation,* 3.2 While the representation of physical quantities in SI units is preferred, IAS recognizes that it is oftentimes necessary for a laboratory to describe its CMC in the units used when performing the calibrations and desired by its customers, in order to provide its customers with a clear and unambiguous description of its capabilities. IAS therefore allows representation of CMC in non-SI units, as needed. Conversion to SI units, where applicable, can be achieved by applying conversion factors as outlined in NIST Special Publication 811.

3.3 Minimum requirements for scope

3.3.1 - Calibration Discipline

The scope of accreditation for calibration laboratories is grouped into general calibration disciplines: Dimensional, Mechanical, Thermal, Electrical (DC/Low Frequency), Time and Frequency, RF/Microwave and Electromagnetics, Optical Radiation, Chemical/Gas.

3.3.2 Calibration and Measurement Capability (CMC)

The contents of the four columns in the scope of accreditation serves to define the accredited laboratory's CMC.

3.3.2.1 Calibration Area Measured Quantity or Device Type Calibrated

This column is used to describe either the type of calibration item, e.g. caliper, micrometer, timer/stopwatch, etc., or the measurement parameter physical quantity to be measured or generated in a more generic form, e.g. Voltage -–Measure, Current --Generate or Current --Source. The term "Generate" or "Source" may be used for electrical to indicate the generation of physical parameters, when the calibration is performed by generating or sourcing a known electrical physical quantity. While the two terms are considered equivalent, the laboratory should be consistent in using one or the other in their particular scope. These generic parameters are always accompanied by a footnote which generically describes the type of device that can be calibrated with this capability.

3.3.2.2 Range

This indicates over which range the stated expanded uncertainty can be achieved. tThe beginning and end of the range should be properly defined. Open ranges must be avoided, since they lead to ambiguity (e.g. range statements such as "above 500 ºC" are not allowed).

3.3.2.33 Expanded Uncertainty

3.3.2.3.1 The uncertainty stated on the scope of accreditation must be expressed as the expanded uncertainty with a coverage probability of approximately 95%. It is supposed to represent the smallest measurement uncertainty that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of ~~nearly ideal measurement standards.~~a best existing device.

~~The uncertainty should be stated in the same unit as the calibration quantity, or relative to that quantity, e.g. percent. Expressions such as ppm (parts per million) should be avoided when expressing uncertainty. Instead, ppm can be expressed as µV/V, µm/m, etc. However, if the term "ppm" has to be used, for example in the case of chemical scopes, an explanation of the abbreviation should be given at the end of the scope.~~

3.3.2.3.2 Note that uncertainties should be stated in the same unit as the calibration quantity, or relative to that quantity, e.g. percent. When uncertainty is expressed as a relative quantity, it usually is relative to the instrument reading or instrument output quantity. IAS has chosen to include the following footnote in its scope template: "When uncertainty is stated in relative terms (such as percent, a multiplier expressed as a decimal fraction or in scientific notation), it is in relation to instrument reading or instrument output, as appropriate, unless otherwise indicated." This allows us to avoid repeated statements of "% of reading" or "% of output." However, if a laboratory wishes to express the uncertainty as % of range or % of full scale, it will be specifically indicated on the scope.

3.3.2.3.3 When stating CMC uncertainties applicable to a range of measurements, care must be taken to avoid ambiguity. The reader of the scope must be able to deduce the measurement uncertainty the laboratory is capable of achieving at any given point in the range. To this end, the laboratory can choose to express its CMC uncertainty in one of the following ways:

3.3.2.3.3.1 A single value valid throughout the range. This stated uncertainty must be achievable throughout the range, hence it may be necessary to overstate the uncertainty for some parts of the range. Sub-ranges can be created to avoid severe overstatement of uncertainties.

3.3.2.3.3.2 Uncertainties expressed as a range, e.g. 1 nm to 10 nm. This is only acceptable if linear interpolation between uncertainty range endpoints accurately reflects the uncertainties that can be achieved for any given point in the measurement range.

3.3.2.3.3.3 An explicit function of a measurand and/or parameter, e.g. 0.045 % of reading + 15 mV.

3.3.2.3.3.4 Matrix or graphical representation may be possible and will be discussed with the laboratory on an individual basis.

3.3.2.4 ~~Technique, Reference Standard, Equipment~~Calibration Method or Procedure, Standard Equipment (Optional)

This section of the scope is used to provide information about the calibration method or calibration procedure, ~~or~~ and the equipment used to achieve the CMC (the latter is optional). The calibration or measurement method must be stated, but a specific internal calibration procedure number or title is not required, as long as the general methodology of the calibration is stated. Listing the standard equipment is optional unless necessary to convey the general methodology. Note that if a published method is cited, it ~~can~~ is ~~be~~ assumed that the latest published version of the method is applied, unless ~~otherwise stated~~there is a valid reason not to do so. In this case, the publication year of the outdated method must be identified. If the laboratory uses a modified version of the method, this must also be indicated.

3.4 Additional guidelines

3.4.1 Unit symbols

3.4.1.1 Symbols for SI and non-SI units as indicated in NIST Special Publication 811 should be used. There should always be a space between the numerical value and the unit symbol. The only exceptions to this are for the unit symbols used for degree, minute and second for plane angle, º, ‘, “, respectively. This means that there should never be a space between the degree symbol (º) when it indicates a plane angle, e.g. 20º3’15’. However, there must always be a space between the number and the unit symbol for degree Celsius, e.g., “20 ºC” instead of “20ºC”, and between the numeric value and all other unit symbols.

3.4.1.2 When multiple or sub-multiple prefixes are used, there is no space between the prefix and the unit, e.g. kg, µV, mL, etc. Since lower case and upper case prefixes indicate different multipliers, it is imperative that the correct case for these prefixes be used, e.g. “kg”, not “Kg”;~~,~~ “mm”, not “MM”, etc. Please refer to Section 3 of the SI Brochure, 9th edition.

3.4.1.3 Expressions such as ppm (parts per million) must be avoided when expressing uncertainty. Instead, ppm can be expressed as µV/V, µm/m, etc., or “parts per 10^6”
~~3.5 Stating CMC uncertainty for a range~~

~~3.5.1 If the uncertainty applies to a range, the beginning and end of the range should be properly defined. Open ranges must be avoided, since they lead to ambiguity (e.g. range statements such as “above 500 ºC” are not allowed).~~

3.4.2~~.5.2~~ The CMC uncertainty can never be zero (e.g. if range includes zero, uncertainty cannot be expressed as percent of reading/output alone, since this would result in an uncertainty of zero).

3.~~5.3~~4.3 In certain cases, where a negative or zero quantity is not physically possible, “up to” may be used as the beginning of a range.

3.~~5.4~~4.4 When expressing ranges, use the word “to” rather than the symbol “-“

3.~~5.5~~ 4.5 ~~While it is preferable to express a~~The measurand or output range ~~in the same units as~~and the associated uncertainties provided ~~for~~ in the CMC must be expressed in the same units. ~~, exceptions~~ Exceptions can be made in rare circumstances to avoid ambiguity. For example, ~~while it is customary~~in some cases the laboratory may prefer to express electric power ranges as a combination of voltage and current, to indicate how the power is generated, ~~but~~ while the uncertainty ~~should still be~~is expressed in units of watts or a multiple thereof.

3.~~5.6~~4.6 For the specification of alternating current (AC) parameters on electrical scopes, they have to be accompanied by either a fixed frequency or frequency range for which the stated uncertainty is valid. While there are many ways to accomplish this in an unambiguous fashion, IAS chooses the following format:

CALIBRATION AREA	RANGE	EXPANDED UNCERTAINTY[3] (±)
AC Voltage Source	33 V to 329.999 V (10 Hz to 45 Hz) (45 Hz to 10 kHz) (10 kHz to 20 kHz) (20 kHz to 50 kHz) (50 kHz to 100 kHz)	 150 µV/V + 1.6 mV 160 µV/V + 4.7 mV 190 µV/V + 4.7 mV 230 µV/V + 4.7 mV 0.16 % + 39 mV

MEASURED QUANTITY or DEVICE TYPE CALIBRATED	**RANGE**	**UNCERTAINTY[1,2] (±)**	**CALIBRATION METHOD OR PROCEDURE, STANDARD EQUIPMENT (OPTIONAL)**
AC Voltage - Generate[3]	1 mV to 200 mV (45 Hz to 1.999 kHz) (2 kHz to 20 kHz)	 0.021 % + 56 µV 0.09 % + 0.23 mV	Using Multi product Calibrator by direct method

	0.2 V to 20 V (45 Hz to 1.999 kHz) (2 kHz to 100 kHz) 20 V to 200 V (40 Hz to 1.999 kHz) (2 kHz to 20 kHz) 200 V to 750 V (40 Hz to 1 kHz)	0.044 % + 0.3 mV 0.47 %+ 0.8 mV 0.045 % + 15 mV 0.096 % + 17 mV 0.039 % + 104 mV	(IS 1248 - Part 9 (For Analog type); IS 13875 - Part 1&2 (For Digital type); CAT-CP-01 (E))

4. REFERENCES

IEEE/ASTM SI 10-2018: American National Standard for Metric Practice
BIPM, The International System of Units (SI), 9th ed.
IEEE/ASTM SI 10-2018: American National Standard for Metric Practic
ILAC-G18:2021 Guideline for describing scopes of accreditation
ILAC-P14: 2013 2020 ILAC Policy for Uncertainty in Calibration
NIST SP 811, 2008 ed.: Guide for the Use of the International System of Units (SI)
IEEE/ASTM SI 10-2018: American National Standard for Metric Practice
BIPM, The International System of Units (SI), 8th ed.
BIPM, The International System of Units, Supplement 2014