Schedule of Accreditation

issued by

United Kingdom Accreditation Service

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0389

Accredited to ISO/IEC 17025:2017

BAE Systems Marine Limited

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Calibration performed at the above address only

DETAIL OF ACCREDITATION

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
PRESSURE			Methods consistent with EURAMET CG3 and CG17
<u>Hydraulic pressure (gauge)</u>			
Determination of effective area of Dead Weight Testers	0.5 MPa to 140 MPa	0.0070 %	
"Pressure equivalent" calibration of Dead Weight Testers (pressure balances supplied with an associated mass set) Calibration of pressure indicating instruments and gauges	0.5 MPa to 140 MPa 140 MPa to 450 MPa	0.0070 % 0.010 % + 0.24 ppm/MPa	
<u>Gas pressure (gauge)</u>			
Determination of effective area of Dead Weight Testers "Pressure equivalent " calibration of Dead Weight Testers (pressure balances supplied with an associated mass set)	3.5 kPa to 700 kPa 700 kPa to 7 MPa	0.0040 % 0.0050 %	
Calibration of pressure indicating instruments and gauges	- 90 kPa to 3.5 kPa 3.5 kPa to 700 kPa 700 kPa to 7 MPa 7 MPa to 20 MPa 20 MPa to 35 MPa 35 MPa to 70 MPa	27 Pa 0.0040 % 0.0050 % 25 kPa 35 kPa 60 kPa	
<u>Gas pressure (absolute)</u>			
Calibration of pressure indicating instruments and gauges.	3.5 kPa to 700 kPa 700 kPa to 7 MPa	0.0040 % + 1.3 Pa 0.0050 % + 1.3 Pa	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
TEMPERATURE			
Resistance thermometers	-20 °C to 0 °C 0 °C to 80 °C 80 °C to 250 °C 250 °C to 300 °C	0.013 °C 0.020 °C 0.020 °C 0.040 °C	Calibration within liquid baths
Thermocouples Base Metal	-20 °C to 300 °C	0.16 °C	Calibration in dry block bath or liquid baths
Electronic thermometers with sensors Analogue Digital	Range as per sensors	As for sensors plus Half scale division One least significant digit	
MASS			
<u>Weights and Artefacts</u>	Nominal value g	mg	
	0.001 0.002 0.005 0.01 0.02 0.05 0.1 0.2 0.5 1 2 5 10 20 50 100 200 500 1000 2000 5000 10 000 20 000 25 000 30 000	0.012 0.012 0.012 0.016 0.020 0.024 0.032 0.040 0.050 0.060 0.080 0.10 0.12 0.16 0.20 0.32 0.60 1.6 3.2 6.0 16 32 60 150 150	Intermediate values can be calibrated but at an appropriate uncertainty which may exceed the value interpolated from the next highest and lowest values. Substitution method

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$)	Remarks
ELECTRICAL			Electrical calibrations are performed as a comparison against a reference standard
DC RESISTANCE			
Specific Values			Decade values using bridge referenced to standard resistor .
	1 mΩ	3.2 ppm	
	10 mΩ	0.99 ppm	
	100 mΩ	0.80 ppm	
	1 Ω	0.30 ppm	
	10 Ω	0.22 ppm	
	100 Ω	0.14 ppm	
	1 kΩ	0.22 ppm	
	10 kΩ	0.32 ppm	
	100 kΩ	1.0 ppm	
	1 MΩ	2.1 ppm	
	10 MΩ	4.4 ppm	
	100 MΩ	7.2 ppm	
	1 GΩ	45 ppm	
Other values	10 μΩ to 1 mΩ	250 ppm	Resistors suitable for oil immersion can be calibrated at specified temperatures from 18 °C to 26 °C
	1 mΩ to 100 mΩ	5.0 ppm	
	100 mΩ to 1 Ω	3.8 ppm	
	1 Ω to 10 Ω	0.80 ppm	
	10 Ω to 100 Ω	0.70 ppm	
	100 Ω to 10 kΩ	0.80 ppm	
	10 kΩ to 100 MΩ	12 ppm	Resistors suitable for high current can be calibrated at test currents up to 100 A
DC VOLTAGE			Sourcing and measurement capability for the calibration of voltage instruments
Standard Cell Values	1.018 V	0.92 ppm	
Other Values	0.1 V	8.5 ppm	
	1 V	0.92 ppm	
	10 V	0.29 ppm	
	100 V	0.53 ppm	
	1000 V	0.70 ppm	
Range Values	0 V to 1 mV	0.60 % + 0.10 μV	
	1 mV to 10 mV	4.0 ppm + 1.2 μV	
	10 mV to 100 mV	4.0 ppm + 1.2 μV	
	100 mV to 1 V	4.0 ppm + 1.2 μV	
	1 V to 10 V	5.0 ppm	
	10 V to 1100 V	10 ppm	
	1 kV to 20 kV	0.060 % + 40 V	
Values for Temperature simulation			
Measurement	- 10 mV to + 120 mV	1.8 μV	
Generation	- 10 mV to + 120 mV	1.8 μV	
DC CURRENT	1 μA to 10 μA	35 ppm	Sourcing and measurement capability for the calibration of current instruments
	10 μA to 1 A	20 ppm	
	1 A to 10 A	25 ppm	
	10 A to 100 A	27 ppm	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
AC VOLTAGE			
Specific Values	0.3 V *10 Hz, 20 Hz, 40 Hz, 300 Hz,* *1 kHz, 10 kHz and 20 kHz* *50 kHz and 100 kHz* *300 kHz, 500 kHz and 1 MHz*	 30 ppm 50 ppm 0.075 %	For the calibration of voltage measuring and generating equipment.
	1 V, 3 V, 10 V and 100 V *10 Hz, 20 Hz, 40 Hz, 300 Hz,* *1 kHz, 10 kHz and 20 kHz* *50 kHz and 100 kHz*	 25 ppm 50 ppm	
	30 V *10 Hz, 300 Hz, 1 kHz, 10 kHz and 20 kHz*	 25 ppm	
	1 V and 10 V *300 kHz, 500 kHz and 1 MHz*	 0.071 %	
	3 V *500 kHz and 1 MHz*	 0.071 %	
	300 V and 1000 V *10 Hz, 20 Hz, 40 Hz, 300 Hz,* *1 kHz, 10 kHz and 20 kHz*	 31 ppm	
	300 V *50 kHz and 100 kHz*	 60 ppm	
	700 V *20 kHz, 50 kHz and 100 kHz*	 0.075 %	
Other values	1 mV to 10 mV *50 Hz to 5 kHz* *5 kHz to 20 kHz*	 0.13 % 1.1 %	For the calibration of voltage measuring and generating equipment.
	10 mV to 31 mV *50 Hz to 5 kHz* *5 kHz to 20 kHz*	 0.017 % 0.11 %	
	0.03 V to 0.1 V *10 Hz to 20 kHz* *20 kHz to 100 kHz* *100 kHz to 1 MHz*	 42 ppm 100 ppm 0.11 %	
	0.1 V to 30 V *10 Hz to 20 kHz* *20 kHz to 100 kHz*	 44 ppm 97 ppm	
	0.1 V to 10 V *100 kHz to 1 MHz*	 0.11 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
AC VOLTAGE (continued)			
Other values (continued)	30 V to 340 V *10 Hz to 20 kHz* *20 kHz to 100 kHz*	 52 ppm 150 ppm	For the calibration of voltage measuring and generating equipment.
	340 V to 1100 V *10 Hz to 20 kHz*	 58 ppm	
	340 V to 700 V *20 kHz to 100 kHz*	 0.075 %	
AC CURRENT	100 μA to 400 mA *40 Hz to 1 kHz*	 130 ppm	
	400 mA to 10 A *40 Hz to 1 kHz*	 190 ppm	
CAPACITANCE	*At 100 Hz* 10 μF to 100 μF 100 μF to 10 mF	 0.36 % 0.40 %	By bridge measurement And transfer
	At 1 kHz: 1 pF to 10 pF 10 pF to 100 pF 100 pF to 100 nF 1 μF to 10 μF	 0.20 % + 0.0020 pF 0.030 % 0.026 % 0.12 %	
	At 10 kHz 1 nF to 1 μF	 0.20 %	
	At 100 kHz 100 pF to 1 nF	 0.38 %	
FREQUENCY MEASUREMENT	0.001 Hz to 0.01 Hz 0.01 Hz to 100 kHz 100 kHz to 500 MHz	0.35 % 2.0 in 10^{11} + 35 μHz 3.0 to 5.0 parts in 10^{11}	
Specific Values	1 MHz, 5 MHz and10 MHz	1.5 parts in 10^{12}	For calibration of frequency standards
TIME INTERVAL	5 ms to 55 ms	0.34 %	
TEMPERATURE SIMULATION			
Type K thermocouples	- 100 °C to 0 ºC	0.13 ºC	Devices fitted with an internal cold junction.
	0 °C to 1370 ºC	0.12 ºC	
PT 100	0 ºC	0.028 ºC	

END

Appendix - Calibration and Measurement Capabilities

Introduction

The definitive statement of the accreditation status of a calibration laboratory is the Accreditation Certificate and the associated Schedule of Accreditation. This Schedule of Accreditation is a critical document, as it defines the measurement capabilities, ranges and boundaries of the calibration activities for which the organisation holds accreditation.

Calibration and Measurement Capabilities (CMCs)

The capabilities provided by accredited calibration laboratories are described by the Calibration and Measurement Capability (CMC), which expresses the lowest uncertainty of measurement that can be achieved during a calibration. If a particular device under calibration itself contributes significantly to the uncertainty (for example, if it has limited resolution or exhibits significant non-repeatability) then the uncertainty quoted on a calibration certificate will be increased to account for such factors. The CIPM-ILAC definition of the CMC is as follows:

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.

The CMC is normally used to describe the uncertainty that appears in an accredited calibration laboratory's schedule of accreditation and is the uncertainty for which the laboratory has been accredited using the procedure that was the subject of assessment. The CMC is calculated according to the procedures given in M3003 and is normally stated as an expanded uncertainty at a coverage probability of 95 %, which usually requires the use of a coverage factor of $k = 2$. An accredited laboratory is not permitted to quote an uncertainty that is smaller than the published CMC in certificates issued under its accreditation.

The CMC may be described using various methods in the Schedule of Accreditation:

As a single value that is valid throughout the range.
As an explicit function of the measurand or of a parameter (see below).
As a range of values. The range is stated such that the customer can make a reasonable estimate of the likely uncertainty at any point within the range.
As a matrix or table where the CMCs depend on the values of the measurand and a further quantity.
In graphical form, providing there is sufficient resolution on each axis to obtain at least two significant figures for the CMC.

Expression of CMCs - symbols and units

In general, only units of the SI and those units recognised for use with the SI are used to express the values of quantities and of the associated CMCs. Nevertheless, other commonly used units may be used where considered appropriate for the intended audience. For example, the term "ppm" (part per million) is frequently used by manufacturers of test and measurement equipment to specify the performance of their products. Terms like this may be used in Schedules of Accreditation where they are in common use and understood by the users of such equipment, providing their use does not introduce any ambiguity in the capability that is being described.

When the CMC is expressed as an explicit function of the measurand or of a parameter, this often comprises a relative term (e.g., percentage) and an absolute term, i.e. one expressed in the same units as those of the measurand. This form of expression is used to describe the capability that can be achieved over a range of values. Some examples are shown below. It should be noted that these expressions are *not* mathematical formulae but are instead written in a commonly used shorthand for expressing uncertainties - therefore, for purposes of clarity, an indication of how they are to be interpreted is also provided below.

DC voltage, 100 mV to 1 V: 0.0025 % + 5.0 µV

Over the range 100 mV to 1 V, the CMC is 0.0025 %·V + 5.0 µV, where V is the measured voltage.

Hydraulic pressure, 0.5 MPa to 140 MPa: 0.0036 % + 0.12 ppm/MPa + 4.0 Pa

Over the range 0.5 MPa to 140 MPa, the CMC is $0.0036\ \%\cdot p + (0.12\cdot 10^{-6}\cdot p\cdot 10^{-6}) + 4.0$ Pa, where p is the measured pressure in Pa.

It should be noted that the percentage symbol (%) simply represents the number 0.01. In cases where the CMC is stated only as a percentage, this is to be interpreted as meaning percentage of the measured value or indication.

Thus, for example, a CMC of 1.5 % means $1.5 \cdot 0.01 \cdot i$, where i is the instrument indication.