Schedule of Accreditation

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NPL Management Ltd

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Calibration performed by the Organisation at the locations specified below

Locations covered by the organisation and their relevant activities

Laboratory locations:

Location details	Activity	Location code
Address National Physical Laboratory Hampton Road Teddington Middlesex TW11 0LW **Local contact** Mr Tahir Maqba, Customer Services Manager Tel: +44 (0)20 8943 6796 Fax: +44 (0)20 8614 0482 Email: tahir.maqba@npl.co.uk	Calibration Chemical Density Dimensional Electromagnetic Fibre optics Flow Force Humidity Mass Optical Pressure Radiological Temperature Time and Frequency Ultrasonics Underwater Acoustics	Teddington
Address Wraysbury Reservoir Coppermill Road Wraysbury Middlesex TW19 5NW **Local contact** Mr J Ablitt Tel: +44 (0)20 8943 6695 Email: justin.ablitt@npl.co.uk	Calibration Underwater Acoustics	Wraysbury

Site activities performed away from the locations listed above:

Location details	Activity	Location Code
Customer's sites or premises The customer's site or premises must be suitable for the nature of the particular calibrations undertaken and will be the subject of contract review arrangements between the laboratory and the customer.	Calibration Time and Frequency Chemical *(Environmental air quality monitoring instruments)*	Customer's sites

DETAIL OF ACCREDITATION

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
DC VOLTAGE *Service Reference ED01*				**Teddington**
Standard cells, not thermostated	1.018 V nominal	0.090 ppm	Measured in a thermostated air enclosure at 20 °C	
Standard cells in a thermostated enclosure	1.018 V nominal	0.090 ppm		
Electronic reference standards	1.0 V 1.018 V 10 V	0.14 ppm 0.14 ppm 0.020 ppm	Supplementary data can be supplied showing detailed behaviour of standard cells or electronic devices	
DC RESISTANCE *Service Reference ED02*	0.1 mΩ 1 mΩ 10 mΩ 100 mΩ 1 Ω 10 Ω 25 Ω 100 Ω 1 kΩ 10 kΩ	2.5 ppm 0.85 ppm 0.80 ppm 0.18 ppm 0.060 ppm 0.050 ppm 0.050 ppm 0.050 ppm 0.050 ppm 0.060 ppm	4 terminal resistors at temperatures between 17 °C and 25 °C and at or less than 1 mW power dissipation	
	100 kΩ 1 MΩ 10 MΩ 100 MΩ	0.080 ppm 0.12 ppm 0.20 ppm 0.40 ppm	2-terminal resistors at temperatures between 17 °C and 25 °C and at or less than 1 mW power dissipation. Values >10 MΩ are not measured in oil.	
	1 GΩ	1.6 ppm	Measured in a 2-terminal configuration, in air, at 20 °C or 23 °C	
Temperature Coefficient	α β	0.0020 ppm K^{-1} 0.0010 ppm K^{-2}	Resistance measurements at 4 temperatures in the range 15 °C to 30 °C. Uncertainty dependent on fit to curve and nominal value of resistor	
Current Carrying Resistors	100 μΩ to 10 Ω	0.50 ppm	For current levels up to 100 A. The uncertainty is dependent on measurement current, nominal value of resistor, elapsed time for which the current is applied and the specific calibration undertaken.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
AC RESISTANCE *Service Reference ED02*				**Teddington**
Specific values	1Ω *40 Hz to 1 kHz* *1 kHz to 2 kHz* *2 kHz to 3 kHz* *3 kHz to 5 kHz* *5 kHz to 10 kHz* *20 kHz*	 5.0 ppm 4.0 ppm 5.0 ppm 6.0 ppm 15 ppm 50 ppm	The uncertainties quoted for AC resistance may depend on the type and construction of the resistor	
Other values	10 Ω to 10 k Ω *40 Hz to 400 Hz* *400 Hz to 2 kHz* *2 kHz to 3 kHz* *3 kHz to 5 kHz* *5 kHz to 10 kHz* *20 kHz*	 1.0 ppm 0.50 ppm 1.2 ppm 1.8 ppm 6.0 ppm 50 ppm	*Exceptions:* 10 Ω/40 Hz: 1.5 ppm 100 Ω/400 Hz to 1.59 kHz: 0.6 ppm 100 Ω/1.59 kHz to 2 kHz: 0.8 ppm 100 Ω/2 kHz to 3 kHz: 1.5 ppm 10 kΩ/10 kHz: 8.0 ppm	
Time constant (τ)	0 ns to ± 200 ns	10 ns	All nominal values and frequencies shown above.	
AC CURRENT RATIO *Service Reference ED07*				
<u>Current Transformers</u>		*Ratio error* *Phase error*		
Ratio and phase error	0.25 A to 0.5 A *50 Hz* 5 A to 1000 A *50 Hz to 400 Hz* 1000 A to 5000 A *50 Hz to 60 Hz* 5 kA to 10 kA *50 Hz*	10 ppm 10 μrad 10 ppm 10 μrad 10 ppm 10 μrad 20 ppm 20 μrad	The CMCs apply to compensated current transformers only. 1 A or 5 A secondary	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)		Remarks	Location Code
Current Transformers (continued)		*Ratio error*	*Phase error*	The CMCs apply to measurements carried out on uncompensated current transformers in accordance with BS EN 61869-2:2012 at unity or 0.8 power factor as specified or required.	Teddington
Ratio and phase error (continued)	*50 Hz to 400 Hz*				
	Class 0.01, 0.02 and 0.03	10 ppm	10 μrad		
	Class 0.1 and higher	30 ppm	30 μrad		
Current Transducers					
with output voltage greater than 0.10V	*50 Hz*	0.050 %			
AC/DC TRANSFER VOLTAGE *Service Reference ED11*					

CMCs for AC/DC Transfer Voltage, at Specific Values, expressed as an Expanded Uncertainty (k = 2) [ppm of value]
For intermediate points the uncertainty will be determined using linear interpolation between the adjacent points.

Voltage	*Frequency*										
	10 Hz	20 Hz to 5 kHz	10 kHz	20 kHz	50 kHz	100 kHz	200 kHz	300 kHz	500 kHz	700 kHz	1 MHz
1 mV	66	66	66	66	71	85	120	180	260	480	800
2 mV	66	57	57	57	59	71	99	140	190	330	510
5 mV	28	28	28	28	33	48	83	120	180	290	460
10 mV	28	28	28	28	33	46	78	110	170	260	410
20 mV	28	28	28	28	31	46	78	110	160	250	370
70 mV	26	26	26	26	31	41	76	110	160	250	370
100 mV	7.0	7.0	7.0	7.0	9.0	14	24	36	58	82	120
200 mV	7.0	7.0	7.0	7.0	9.0	14	24	36	58	82	120
300 mV	6.0	6.0	6.0	6.0	7.0	11	20	29	48	68	96
500 mV	6.0	6.0	6.0	6.0	7.0	10	16	23	38	54	76
1 V	6.0	6.0	6.0	6.0	7.0	7.0	13	17	25	38	51
2 V	6.0	6.0	6.0	6.0	6.0	7.0	10	12	17	27	38
3 V	6.0	6.0	6.0	6.0	6.0	7.0	10	12	17	27	38
4 V	6.0	6.0	6.0	6.0	6.0	6.0	8.0	9.0	13	21	31
5 V	6.0	6.0	6.0	6.0	6.0	6.0	8.0	9.0	13	21	31
10 V	6.0	6.0	6.0	6.0	6.0	6.0	8.0	10	15	22	32
20 V	6.0	6.0	6.0	6.0	6.0	7.0	9.0	11	16	25	34
30 V	6.0	6.0	6.0	6.0	6.0	7.0	11				
50 V	7.0	7.0	7.0	7.0	7.0	10	14				
70 V	7.0	7.0	7.0	7.0	7.0	10	14				
100 V	7.0	7.0	7.0	7.0	7.0	10	14				
200 V	8.0	8.0	8.0	10	13	22					
300 V	8.0	8.0	8.0	10	13	22					
500 V	11	9.0	10	15	24	42					
600 V	11	9.0	10	19	29	52					
700 V	11	9.0	10	19	29	52					
1 kV	11	9.0	11	23	33	62					

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
AC/DC TRANSFER VOLTAGE (continued) AC VOLTAGE *Service Reference ED11*				**Teddington**

CMCs for AC Voltage, at Specific Values, expressed as an Expanded Uncertainty (k = 2) [ppm of value]
For intermediate points the uncertainty will be determined using linear interpolation between the adjacent points.

Voltage	*Frequency*										
	10 Hz	20 Hz to 5 kHz	10 kHz	20 kHz	50 kHz	100 kHz	200 kHz	300 kHz	500 kHz	700 kHz	1 MHz
500 mV	8.0	8.0	8.0	8.0	10	13	20	28	43	62	86
1 V	8.0	8.0	8.0	9.0	11	13	18	22	30	43	60
2 V	8.0	8.0	8.0	8.0	9.0	11	14	17	23	31	43
3 V	8.0	8.0	8.0	8.0	9.0	8.0	14	15	21	29	41
4 V	7.0	7.0	7.0	7.0	7.0	7.0	9.0	11	15	22	32
5 V	7.0	7.0	7.0	7.0	7.0	7.0	9.0	11	15	22	32
10 V	7.0	7.0	7.0	7.0	7.0	8.0	9.0	11	16	24	34
20 V	7.0	7.0	7.0	7.0	7.0	9.0	10	13	17	27	35
30 V	7.0	7.0	7.0	7.0	7.0	9.0	11				
50 V	8.0	8.0	8.0	8.0	8.0	12	15				
70 V	8.0	8.0	8.0	8.0	8.0	12	15				
100 V	8.0	8.0	8.0	8.0	8.0	12	15				
200 V	9.0	9.0	9.0	10	13	22					
300 V	9.0	9.0	9.0	10	13	22					
500 V	12	10	11	15	25	42					
600 V	12	10	11	19	29	52					
700 V	12	10	11	19	29	52					
1 kV	12	10	12	23	33	62					

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code

AC/DC TRANSFER CURRENT
Service Reference ED11

CMCs for AC/DC Transfer Current, at Specific Values, expressed as an Expanded Uncertainty (k = 2) [ppm of value]
For intermediate points the uncertainty will be determined using linear interpolation between the adjacent points.

Current	*Frequency*												
	10 Hz	20 Hz	40 Hz	100 Hz	400 Hz	1 kHz	2 kHz	5 kHz	10 kHz	20 kHz	50 kHz	70 kHz	100 kHz
1 mA	31	30	30	30	30	30	30	30	30	31	31	33	35
2 mA	17	17	16	16	16	16	16	16	17	18	19	22	25
3 mA	12	12	12	12	12	12	12	12	13	14	16	19	22
5 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
10 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
20 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
30 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
50 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
0.1 A	14	13	12	12	12	12	12	12	12	13	20	23	42
0.2 A	23	20	16	16	16	16	16	16	16	17	28	33	61
0.25 A	23	20	16	16	16	16	16	16	16	17	28	33	61
0.3 A	30	26	16	17	16	18	16	17	15	24	43	52	81
0.5 A	30	26	16	17	16	18	16	17	15	24	43	52	81
1 A	38	31	19	19	19	20	17	18	17	33	53	62	100
2 A	47	37	22	20	21	22	20	21	20	43	63	83	120
2.5 A	47	37	22	20	21	22	20	21	20	43	63	83	120
3 A	55	43	25	23	24	24	23	21	22	53	83	100	160
5 A	55	43	25	23	24	24	23	21	22	53	83	100	160
10 A	63	49	27	25	26	26	25	26	23	62	100	120	200
20 A	72	56	31	28	30	29	28	29	28	73	120	140	240

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Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
AC VOLTAGE RATIO (continued) *Service Reference ED13* <u>Inductive Voltage Dividers</u> Voltage ratio		Voltage ratio uncertainty with respect to input voltage (x 10^{-8}) *In-phase* *Quadrature*		**Teddington**
	LF System		Normal operating range: Minimum voltage: 1 V Maximum voltage: 0.1 x *f*(Hz) from 40 Hz to 80 Hz; 0.15 x *f*(Hz) from 100 Hz to 200 Hz; 30 V otherwise.	
	40 Hz	16 17		
	60 Hz	16 17		
	80 Hz	12 14		
	100 Hz	9.2 11		
	120 Hz	7.1 8.4		
	200 Hz	6.1 7.7		
	300 Hz	6.1 6.9		
	400 Hz	6.1 6.9		
	600 Hz	6.1 6.9		
	800 Hz	6.1 6.9		
	1000 Hz	6.1 6.9		
	1300 Hz	6.1 6.9		
	1592 Hz	6.1 6.9		
	2000 Hz	6.8 8.0		
	3000 Hz	9.1 9.8		
	4000 Hz	14 14		
	5000 Hz	21 21		
	HF System		Normal operating range: Minimum voltage: 1 V Maximum voltage: 30 V	
	5 kHz	21 21		
	8 kHz	30 30		
	10 kHz	38 38		
	20 kHz	72 75		
	30 kHz	120 120		
	40 kHz	180 190		
	50 kHz	280 300		
	80 kHz	630 650		
	100 kHz	990 1000		
	120 kHz	1500 1600		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$)	Remarks	Location Code
AC POWER *Service Reference ED06*				**Teddington**
Sinusoidal waveforms	*40 Hz to 400 Hz:* Current 2 mA to 130 A Voltage 1 V to 1000 V	40 µW/VA 25 µW/VA	20 °C and 23 °C at unity power factor 20 °C and 23 °C at zero power factor *Uncertainties increase at other power factors*	
Current Response of Wattmeters	2 mA to 20 A	30 µW/VA	20 °C and 23 °C	
Voltage Response of Wattmeters	1 V to 1000 V	25 µW/VA	20 °C and 23 °C	
Auxiliary DC Voltage	DC, 1 V to 10 V	5.0 ppm of value	20 °C and 23 °C	
AC REACTIVE VOLT-AMPERES *Sinusoidal waveforms*	*50 Hz to 400 Hz:* Current 2 mA to 130 A Voltage 1 V to 1000 V	40 µW/VA 25 µW/VA	20 °C and 23 °C at zero power factor 20 °C and 23 °C at unity power factor *Uncertainties increase at other power factors*	
CALIBRATION OF EN 61000 HARMONIC AND FLICKER ANALYSERS *Service Reference ED17*				
Sinusoidal waveforms				
Current accuracy	100 mA to 20 A, *50 Hz*	40 ppm		
Current frequency response	100 mA to 20 A *50 Hz to 2 kHz*	150 ppm		
Voltage accuracy	1 V to 1000 V, *50 Hz*	30 ppm		
Power measurements	Ranges as in *AC Power* above	45 ppm of full-scale	At unity power factor	
Non-sinusoidal waveforms				
Harmonic measurements for current waveforms	Peak values 1A to 10 A 50 Hz fundamental; harmonics up to 2 kHz	200 ppm	Steady-state, burst fluctuating or smoothly fluctuating harmonics	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)		Remarks	Location Code
CALIBRATION OF EN 61000 HARMONIC AND FLICKER ANALYSERS (continued)					**Teddington**
Flicker (Pst)	0.95 Pst to 1.05 Pst Square or sine wave modulated, 230 V 50 Hz sine wave	0.30 % of Pst reading			
	0.95 Pst to 2.05 Pst Complex waveforms, 230 V 50 Hz sine wave	0.20 % of Pst reading		See the NPL web site for details about these complex waveforms.	
CAPACITANCE and DISSIPATION FACTOR *Service Reference ED04*				Capacitance and dissipation factor measurements are normally carried out between 20 °C and 23 °C but may exceptionally be carried out at any temperature between 18 °C and 25 °C.	
Fused-silica dielectric capacitors	*At 1 kHz and 1.592 kHz*	C	D		
	10 pF	0.70 ppm	6.0×10^{-6}		
	100 pF	0.90 ppm	7.0×10^{-6}		
Other types of capacitor	1 nF				
	1 kHz	3.0 ppm	20×10^{-6}		
	1.592 kHz	3.0 ppm	20×10^{-6}		
	10 kHz	5.0 ppm	20×10^{-6}		
	100 kHz	200 ppm	80×10^{-6}		
	1 MHz	500 ppm	5.0×10^{-4}		
	At 1 kHz and 1.592 kHz				
	1 pF to 10 pF	4.0 ppm	10×10^{-6}	These measurements can also be made at frequencies from 20 Hz to 1 MHz, depending on value, but with increased uncertainties.	
	10 pF to 1 nF	3.0 ppm	7.0×10^{-6}		
	1 nF to 100 nF	30 ppm	20×10^{-6}		
	100 nF to 1 μF	60 ppm	20×10^{-6}		
General Radio Type 1417	1 μF to 10 mF				
	100 Hz, 120 Hz and 1 kHz	0.10 % to 0.50 %	0.0010 to 0.0005		
	100 mF to 1 F				
	100 Hz and 120 Hz	0.30 % to 1.0 %	0.0030 to 0.010		
Dissipation Factor Standard	0.0 to 0.001				
	1 kHz	20×10^{-6}			
	0.0 to 0.005				
	50 Hz	20×10^{-6}			

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
SELF-INDUCTANCE *Service Reference ED05*				**Teddington**

Expanded uncertainty at 95% confidence level (k = 2) for the frequencies shown

Nominal value	20 Hz	50 Hz	100 Hz 400 Hz	1 kHz	1.592 kHz 2 kHz	5 kHz	10 kHz
1 μH			2.0 %	0.10 %	0.10 %	0.25 %	0.35 %
2 μH			1.0 %	0.10 %	0.10 %	0.22 %	0.30 %
3 μH			0.61 %	0.10 %	0.10 %	0.22 %	0.26 %
5 μH			0.35 %	600 ppm	600 ppm	0.11 %	0.15 %
10 μH	0.35 %	0.25 %	0.20 %	310 ppm	350 ppm	620 ppm	930 ppm
20 μH	0.18 %	0.13 %	0.10 %	150 ppm	160 ppm	320 ppm	460 ppm
30 μH	0.12 %	840 ppm	670 ppm	110 ppm	120 ppm	190 ppm	260 ppm
50 μH	700 ppm	500 ppm	400 ppm	100 ppm	100 ppm	160 ppm	200 ppm
100 μH	300 ppm	200 ppm	150 ppm	75 ppm	80 ppm	120 ppm	150 ppm
200 μH	250 ppm	180 ppm	100 ppm	75 ppm	85 ppm	110 ppm	150 ppm
300 μH	250 ppm	180 ppm	100 ppm	85 ppm	85 ppm	120 ppm	150 ppm
500 H	220 ppm	160 ppm	100 ppm	80 ppm	80 ppm	100 ppm	150 ppm
1 mH	180 ppm	150 ppm	95 ppm	70 ppm	75 ppm	100 ppm	150 ppm
2 mH	180 ppm	150 ppm	100 ppm	75 ppm	80 ppm	110 ppm	150 ppm
3 mH	180 ppm	150 ppm	100 ppm	85 ppm	85 ppm	120 ppm	150 ppm
5 mH	180 ppm	160 ppm	100 ppm	80 ppm	80 ppm	110 ppm	150 ppm
10 mH	180 ppm	150 ppm	100 ppm	70 ppm	70 ppm	100 ppm	130 ppm
20 mH	180 ppm	150 ppm	100 ppm	75 ppm	75 ppm	110 ppm	130 ppm
30 mH	180 ppm	150 ppm	100 ppm	85 ppm	85 ppm	110 ppm	150 ppm
50 mH	200 ppm	160 ppm	100 ppm	80 ppm	80 ppm	160 ppm	200 ppm
100 mH	190 ppm	150 ppm	85 ppm	70 ppm	70 ppm	140 ppm	200 ppm
200 mH	230 ppm	200 ppm	90 ppm	75 ppm	75 ppm	200 ppm	300 ppm
400 mH	240 ppm	200 ppm	90 ppm	75 ppm	75 ppm	200 ppm	380 ppm
500 mH	240 ppm	210 ppm	90 ppm	80 ppm	80 ppm	200 ppm	400 ppm
1 H	140 ppm	110 ppm	85 ppm	70 ppm	70 ppm	200 ppm	400 ppm
2 H	140 ppm	110 ppm	85 ppm	70 ppm	70 ppm		
5 H	140 ppm	110 ppm	85 ppm	80 ppm	85 ppm		
10 H	140 ppm	110 ppm	85 ppm	80 ppm	85 ppm		

MUTUAL INDUCTANCE *Service Reference ED05*	*At 1 kHz:* 1 mH 5 mH 10 mH 100 mH	 100 ppm 80 ppm 70 ppm 70 ppm	

NOTE

Inductance measurements are normally carried out between 20 °C and 23 °C but may exceptionally be carried out at any temperature between 18 °C and 25 °C. The DC resistance of an inductor can also be reported as an indication of its temperature. Inductance measurements may be made at other frequencies between 20 Hz and 10 kHz, but the uncertainties may be increased.

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k=2)	Remarks	Location Code
MAGNETIC QUANTITIES *Service Reference MT41*				**Teddington**
DC MAGNETIC FIELD STRENGTH AND MAGNETIC FLUX DENSITY				
	0.8 mA/m (1 nT) to 16 A/m (20 μT)	0.15 % + 0.4 mA/m (0.5 nT)		
	16 A/m (20 μT) to 72 A/m (90 μT)	0.0030 %		
	72 A/m (90 μT) to 280 A/m (350 μT)	0.050 %		
	280 A/m (350 μT) to 40 kA/m (50 mT)	0.20 %		
	40 kA/m (50 mT) to 10.5 MA/m (13 T)	0.0015 %		
AC MAGNETIC FIELD STRENGTH AND MAGNETIC FLUX DENSITY				
	8 mA/m (10 nT) to 17.5 kA/m (22 mT) *10 Hz to 60 Hz*	0.25 %		
	8 mA/m (10 nT) to 80 A/m (100 μT) *60 Hz to 20 kHz*	0.25 %		
	8 mA/m (10 nT) to 40 A/m (50 μT) *20 kHz to 50 kHz*	0.40 %		
	8 mA/m (10 nT) to 15.9 A/m (20 μT) *50 kHz to 120 kHz*	0.70 %		
MAGNETIC FIELD STRENGTH TO CURRENT RATIO				
Standard solenoids and Helmholtz coils	1 A/m/A to 20 000 A/m/A *DC* *12 Hz to 60 Hz* *60 Hz to 20 kHz*	 0.015 % 0.050 % 0.25 %		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k=2)	Remarks	Location Code
MAGNETIC QUANTITIES (continued)				**Teddington**
TURN AREA (effective area)				
Search coils	0.0029 m^2 to 17 m^2 *12 Hz to 60 Hz*	 0.090 %		
	0.0001 m^2 to 200 m^2 *60 Hz to 20 kHz* *20 kHz to 50 kHz* *50 kHz to 120 kHz*	 0.25 % 0.40 % 0.70 %		
NORMAL DC MAGNETIZATION CURVES AND HYSTERESIS LOOPS				
Ring specimens	H = 0.1 kA/m to 10 kA/m B = 0.05 T to 2.5 T	0.40 % 0.40 %	In accordance with EN 60404 Part 4: 1997 and IEC 60404 Part 4:2008	
Bar or rod specimens	H = 0.1 kA/m to 200 kA/m B = 0.05 T to 2.5 T	0.40 % 0.40 %	In accordance with EN 60404 Part 4: 1997 and IEC 60404 Part 4:2008	
DC DEMAGNETIZATION CURVE FOR HARD MAGNETIC MATERIALS				
Remanence	B_r = 0.02 T to 2 T	0.30 %	In accordance with BS EN 60404 Part 5: 2007 and IEC 60404 Part 5: 2007	
Coercivity	H_{CB} = 0.03 to 1.2 MA/m H_{CJ} = 0.03 to 1.6 MA/m	0.40 % 0.40 %		
Maximum energy product	$(B.H)_{max}$ = 1 to 400 kJ/m^3	0.50 %		
DC RELATIVE MAGNETIC PERMEABILITY, μ_r				
For low magnetic Permeability materials	(μ_r – 1) = 0.001 to 1.5 (μ_r – 1) = 0.0002 to 0.001	0.20 % 2.2 %	In accordance with BS EN 60404 Part 15: 2012	
Permeability measuring instruments and indicators	(μ_r – 1) = 0.001 to 1.5	0.20 %	The uncertainty may be increased depending on the characteristics of the device being calibrated	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k=2)	Remarks	Location Code
MAGNETIC QUANTITIES (continued)				**Teddington**
MAGNETIC DIPOLE MOMENT	0.06 Am^2 to 1000 Am^2	0.11 %		
SPECIFIC TOTAL POWER LOSS				
For Epstein strips and 500 mm sheets	0.02 W/kg to 120 W/kg		Method of measurement:	
Non-oriented material	*At 50 Hz and 60 Hz* J = 0.1 T to 1.3 T J = 1.3 T to 1.7 T	 0.65 % 0.75 %	For strips: IEC 60404 Part 2:2008 BS EN 60404 Part 2:1998 For sheets: IEC 60404 Part 3:2010 BS EN 10280:2001	
Oriented material	*At 50 Hz and 60 Hz* J = 0.1 T to 1.7 T J = 1.7 T to 1.8 T	 0.65 % 0.75 %		
For Epstein strips only	0.02 W/kg to 120 W/kg			
Non-oriented material	*At 400 Hz* J = 0.1 T to 1.3 T J = 1.3 T to 1.7 T	 0.70 % 1.8 %	Measurements can be made at frequencies up to 16 kHz but with an increase in uncertainty using IEC 60404 Part 10:1988 BS EN 10252:1997	
Oriented material	*At 400 Hz* J = 0.1 T to 1.7 T J = 1.7 T to 1.8 T	 0.70 % 1.8 %		
Soft magnetic materials in ring form only	0.02 W/kg to 120 W/kg *50 Hz to 100 kHz* J = 1 mT to 100 mT	 0.65 %		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k=2)	Remarks	Location Code
MAGNETIC QUANTITIES (continued)				**Teddington**
APPARENT POWER	0.06 VA/kg to 400 VA/kg			
Non-oriented material	At *50 Hz and 60 Hz* J = 0.1 T to 1.3 T J = 1.3 T to 1.5 T J = 1.5 T to 1.7 T	 1.1 % 1.5 % 2.6 %		
Oriented material	At *50 Hz and 60 Hz* J = 0.1 T to 1.5 T J = 1.5 T to 1.8 T	 1.1 % 2.6 %	Method of measurement: For strips: IEC 60404 Part 2:2008 BS EN 60404-2: 1998 For sheets: IEC 60404 Part 3:2010 BS EN 10280: 2001	
For Epstein strips only	*At 400 Hz* J = 0.1 T to 1.0 T J = 1.0 T to 1.5 T	 1.1 % 2.6 %		
Soft magnetic materials in ring form only	*50 Hz to 100 kHz* J = 1 mT to 100 mT	 1.1 %		
AC PERMEABILITY (rms or peak values)				
Oriented and non-oriented materials	μ_r = 500 to 200 000 *At 50 Hz and 60 Hz* B = 0.5 T to 2.2 T H = 0.5 kA/m to 10 kA/m	 0.45 %		
AC MAGNETIC FIELD STRENGTH (rms or peak values)			Method of measurement (for strips) in accordance with IEC 60404 Part 2: 2008, BS EN 60404 Part 2:1998 and (for sheets), IEC 60404 Part 3:2010 BS EN 10280: 2001.	
Oriented and non-oriented materials	*At 50 Hz and 60 Hz* H = 0.5 kA/m to 10 kA/m	 0.45 %		
AC CONDUCTIVITY *Service Reference MT41*				
AC conductivity reference materials	2 MS/m to 60 MS/m (3.45 $\%_{IACS}$ to 103 $\%_{IACS}$) *60 kHz, 20°C*	 0.70 %	Calibration of sets of reference materials produced by NPL.	
AC conductivity instruments	2 MS/m to 60 MS/m (3.45 $\%_{IACS}$ to 103 $\%_{IACS}$) *60 kHz, 20°C*	 0.70 %		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
POWER FLUX DENSITY *Service Reference EF01*				**Teddington**
	0.11 nW/cm^2 to 170 mW/cm^2 *10 Hz to 10 kHz*	0.68 dB	TEM Cells The maximum frequency and power flux density level is determined by the size of the probe.	
	0.11 nW/cm^2 to 265 mW/cm^2 *10 kHz to 300 MHz*	0.68 dB		
	0.17 nW/cm^2 to 120 mW/cm^2 *180 MHz to 1000 MHz*	0.80 dB	Tapered TEM Cell The maximum frequency and power flux density level is determined by the size of the probe.	
	0.17 nW/cm^2 to 64 mW/cm^2 *1000 MHz to 3000 MHz*	0.80 dB		
	0.03 nW/cm^2 to 38 mW/cm^2 *240 MHz to 270 MHz*	0.65 dB	Anechoic Chambers The Listed Field levels are derived from the lowest unsaturated maximum power in each range. The actual achievable level may be up to 20 % greater than the stated limit. All probes and small active dipoles	
	0.03 nW/cm^2 to 65 mW/cm^2 *270 MHz to 350 MHz*	0.65 dB	All probes and small active dipoles	
	0.03 nW/cm^2 to 87 mW/cm^2 *350 MHz to 500 MHz*	0.65 dB	All probes and small active dipoles	
	0.03 nW/cm^2 to 37 mW/cm^2 *450 MHz to 550 MHz*	0.62 dB	All probes and small active dipoles	
	0.03 nW/cm^2 to 72 mW/cm^2 *550 MHz to 750 MHz*	0.62 dB	All probes and small active dipoles	
	0.03 nW/cm^2 to 72 mW/cm^2 *750 MHz to 950 MHz*	0.62 dB	All probes and small active dipoles	
	0.03 nW/cm^2 to 38 mW/cm^2 *950 MHz to 1200 MHz*	0.62 dB	All probes and small active dipoles	
	0.03 nW/cm^2 to 138 mW/cm^2 *1100 MHz to 1250 MHz*	0.47 dB	All probes and small active dipoles	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
POWER FLUX DENSITY (continued)				Teddington
	0.03 nW/cm^2 to 170 mW/cm^2 *1250 MHz to 1700 MHz*	0.47 dB	All probes and small active dipoles	
	0.03 nW/cm^2 to 227 mW/cm^2 *1700 MHz to 2600 MHz*	0.47 dB	All probes and small active dipoles	
	0.7 nW/cm^2 to 569 mW/cm^2 *2.45 GHz to 2.7 GHz*	0.40 dB	All probes and small active dipoles	
	0.7 nW/cm^2 to 921 mW/cm^2 *2.7 GHz to 8.2 GHz*	0.40 dB	All probes and small active dipoles	
	0.7 nW/cm^2 to 694 mW/cm^2 *8.2 GHz to 18 GHz*	0.40 dB	All probes and small active dipoles	
	1.7 µW/cm^2 to 92 mW/cm^2 *18 GHz to 40 GHz*	0.35 dB	All probes and small active dipoles	
	60 µW/cm^2 to 2.7 mW/cm^2 *43.5 GHz to 45.5 GHz*	0.35 dB	All probes and small active dipoles	
FIELD STRENGTH *Service Reference EF01*				
Electric Field	0.02 V/m to 800 V/m *10 Hz to 10 kHz*	0.68 dB	<u>TEM Cells</u> The maximum frequency and field strength level is determined by the size of the probe.	
	0.02 V/m to 1000 V/m *10 kHz to 300 MHz*	0.68 dB		
	0.008 V/m to 670 V/m *180 MHz to 1000 MHz*	0.80 dB	<u>Tapered TEM Cell</u> The maximum frequency and field strength level is determined by the size of the probe.	
	0.008 V/m to 490 V/m *1000 MHz to 3000 MHz*	0.80 dB		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
FIELD STRENGTH (continued)			Anechoic Chambers The Listed Field levels are derived from the lowest unsaturated maximum power in each range. The actual achievable level may be up to 20 % greater than the stated limit.	Teddington
Electric Field	0.01 V/m to 380 V/m *240 MHz to 270 MHz*	0.65 dB	All probes and small active dipoles	
	0.01 V/m to 500 V/m *270 MHz to 350 MHz*	0.65 dB	All probes and small active dipoles	
	0.01 V/m to 575 V/m *350 MHz to 500 MHz*	0.65 dB	All probes and small active dipoles	
	0.01 V/m to 375 V/m *450 MHz to 550 MHz*	0.62 dB	All probes and small active dipoles	
	0.01 V/m to 520 V/m *550 MHz to 750 MHz*	0.62 dB	All probes and small active dipoles	
	0.01 V/m to 520 V/m *750 MHz to 950 MHz*	0.62 dB	All probes and small active dipoles	
	0.01 V/m to 380 V/m *950 MHz to 1200 MHz*	0.62 dB	All probes and small active dipoles	
	0.01 V/m to 720 V/m *1100 MHz to 1250 MHz*	0.47 dB	All probes and small active dipoles	
	0.01 V/m to 800 V/m *1250 MHz to 1700 MHz*	0.47 dB	All probes and small active dipoles	
	0.01 V/m to 920 V/m *1700 MHz to 2600 MHz*	0.47 dB	All probes and small active dipoles	
	0.05 V/m to 1460 V/m *2.45 GHz to 2.7 GHz*	0.40 dB	All probes and small active dipoles	
	0.05 V/m to 1860 V/m *2.7 GHz to 8.2 GHz*	0.40 dB	All probes and small active dipoles	
	0.05 V/m to 1610 V/m *8.2 GHz to 18 GHz*	0.40 dB	All probes and small active dipoles	
	2.5 V/m to 590 V/m *18 GHz to 40 GHz*	0.35 dB	All probes and small active dipoles	
	15 V/m to 100 V/m *43.5 GHz to 45.5 GHz*	0.35 dB	All probes and small active dipoles	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
FIELD STRENGTH (continued) Magnetic Field			TEM Cells The maximum frequency and field strength level is determined by the size of the probe.	Teddington
	0.05 mA/m to 2.1 A/m *10 Hz to 100 Hz*	1.35 dB	Electrically small probes	
	0.05 mA/m to 2.1 A/m *100 Hz to 500 Hz*	0.76 dB	Electrically small probes	
	0.05 mA/m to 2.1 A/m *500 Hz to 10 kHz*	0.68 dB	Electrically small probes	
	0.05 mA/m to 2.1 A/m *10 kHz to 300 MHz*	0.68 dB	Electrically small probes	
			Tapered TEM Cell The maximum frequency and field strength level is determined by the size of the probe.	
	0.021 mA/m to 1.8 A/m *180 MHz to 1000 MHz*	0.80 dB	Electrically small probes	
	0.021 mA/m to 1.3 A/m *1000 MHz to 3000 MHz*	0.80 dB	Electrically small probes	
			Anechoic Chambers The Listed Field levels are derived from the lowest unsaturated maximum power in each range. The actual achievable level may be up to 20 % greater than the stated limit.	
	0.03 mA/m to 1.0 A/m *240 MHz to 270 MHz*	0.65 dB	All probes and small active dipoles	
	0.03 mA/m to 1.3 A/m *270 MHz to 350 MHz*	0.65 dB	All probes and small active dipoles	
	0.03 mA/m to 1.5 A/m *350 MHz to 500 MHz*	0.65 dB	All probes and small active dipoles	
	0.03 mA/m to 1.0 A/m *450 MHz to 550 MHz*	0.62 dB	All probes and small active dipoles	
	0.03 mA/m to 1.4 A/m *550 MHz to 750 MHz*	0.62 dB	All probes and small active dipoles	
	0.03 mA/m to 1.4 A/m *750 MHz to 950 MHz*	0.62 dB	All probes and small active dipoles	
	0.03 mA/m to 1.0 A/m *950 MHz to 1200 MHz*	0.62 dB	All probes and small active dipoles	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
FIELD STRENGTH (continued) Magnetic Field (continued)				**Teddington**
	0.03 mA/m to 1.9 A/m *1100 MHz to 1250 MHz*	0.47 dB	All probes and small active dipoles	
	0.03 mA/m to 2.1 A/m *1250 MHz to 1700 MHz*	0.47 dB	All probes and small active dipoles	
	0.03 mA/m to 2.4 A/m *1700 MHz to 2600 MHz*	0.47 dB	All probes and small active dipoles	
PFD and Field Strength Indicating Meters				
Injected DC Voltage	0.15 mV to 1 V	0.47 %	Meter Sensitivity	
Measured DC Voltage	0.09 V to 3.5 V	0.44 %	Analogue output voltage for FSD	
DC Current	5 mA to 100 mA	0.10 %	Battery Charge	
AC Voltage	1 V to 5 V, *8 kHz to 12 kHz*	0.60 %	Low frequency source check	
Frequency	8 kHz to 12 kHz	0.012 %	Low frequency source check	
Time Interval	2 s to 660 s	0.10 s	Response time and maximum hold	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
ANTENNA GAIN *Service Reference EF03*			All measurements are performed at 23 °C	**Teddington**
Waveguide Feed	0 dB to 23 dB *2.6 GHz to 3.95 GHz*	0.050 dB	Waveguide No 10	
	0 dB to 24 dB *3.3 GHz to 4.9 GHz*	0.050 dB	Waveguide No 11A	
	0 dB to 25 dB *3.95 GHz to 5.85 GHz*	0.050 dB	Waveguide No 12	
	0 dB to 26 dB *5.4 GHz to 8.2 GHz*	0.050 dB	Waveguide No 14	
	0 dB to 27 dB *7.05 GHz to 10.0 GHz*	0.050 dB	Waveguide No 15	
	0 dB to 28 dB *8.2 GHz to 12.4 GHz*	0.050 dB	Waveguide No 16	
	0 dB to 29 dB *10.0 GHz to 15.0 GHz*	0.050 dB	Waveguide No 17	
	0 dB to 29 dB *12.4 GHz to 18.0 GHz*	0.040 dB	Waveguide No 18	
	0 dB to 31 dB *18.0 GHz to 26.5 GHz*	0.040 dB	Waveguide No 20	
	0 dB to 33 dB *26.5 GHz to 40.0 GHz*	0.040 dB	Waveguide No 22	
	0 dB to 34 dB *33 GHz to 50 GHz* *0 dB to 35 dB*	0.060 dB	Waveguide No 23	
	40 GHz to 60 GHz	0.10 dB	Waveguide No 24	
	0 dB to 36 dB *50 GHz to 75 GHz*	0.10 dB	Waveguide No 25	
	0 dB to 37 dB *75 GHz to 110 GHz*	0.10 dB	Waveguide No 27	
Coaxial Feed	0 dB to 28 dB *1 GHz to 18 GHz*	0.050 dB	50 Ω APC-7 or Type N connectors	
	0 dB to 28 dB *1 GHz to 26.5 GHz*	0.050 dB	50 Ω 3.5 mm connector	
	0 dB to 28 dB *1 GHz to 40 GHz*	0.09 dB	50 Ω 2.92 mm connector	

The uncertainties apply to calibrations covering a waveguide bandwidth.

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
Coaxial Feed (cont'd)	0 dB to 28 dB *2.6 GHz to 50 GHz*	0.10 dB	50 Ω 2.4 mm connector Devices fitted with coaxial connectors other than those listed may be calibrated but the uncertainties may be increased	
EMC ANTENNA CALIBRATION *Service Reference EF04*				
Waveguide Feed	0 dB to 21 dB *2.6 GHz to 3.95 GHz*	0.70 dB	Waveguide No 10	
	0 dB to 22 dB *3.3 GHz to 4.9 GHz*	0.70 dB	Waveguide No 11A	
	0 dB to 23 dB *3.95 GHz to 5.85 GHz*	0.70 dB	Waveguide No 12	
	0 dB to 24 dB *5.4 GHz to 8.2 GHz*	0.70 dB	Waveguide No 14	
	0 dB to 25 dB *7.05 GHz to 10.0 GHz*	0.70 dB	Waveguide No 15	
	0 dB to 26 dB *8.2 GHz to 12.4 GHz*	0.70 dB	Waveguide No 16	
	0 dB to 27 dB *10.0 GHz to 15.0 GHz*	0.70 dB	Waveguide No 17	
	0 dB to 28 dB *12.4 GHz to 18.0 GHz*	0.70 dB	Waveguide No 18	
	0 dB to 30 dB *18.0 GHz to 26.5 GHz*	0.70 dB	Waveguide No 20	
	0 dB to 31 dB *26.5 GHz to 40.0 GHz*	0.70 dB	Waveguide No 22	
	0 dB to 31 dB *43.5 GHz to 45.5 GHz*	0.70 dB	Waveguide No 23	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	
Coaxial Feed	0 dB to 28 dB *1 GHz to 18 GHz*	0.80 dB (0.60 dB for conical log spiral antennas)	50 Ω APC-7 or Type N connectors	For coaxially fed antennas the antenna factor is calculated from the antenna gain. Devices fitted with coaxial connectors other than those listed above may be calibrated but the uncertainties may be increased.
	0 dB to 30 dB *1 GHz to 26.5 GHz*	0.80 dB (0.60 dB for conical log spiral antennas)	50 Ω 3.5 mm connectors	
	0 dB to 30 dB *18 GHz to 40 GHz*	0.80 dB	50 Ω 2.92 mm connectors	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
ANTENNA COMPLEX REFLECTION COEFFICIENT	0 to 0.5, real and imaginary parts, higher reflections with increased uncertainty.		The uncertainties for complex reflection coefficient apply to both real and imaginary parts. All measurements are performed at 23 °C	Teddington
Waveguide feed	*2.6 GHz to 3.95 GHz*	0.0080	Waveguide No 10	
	3.3 GHz to 4.9 GHz	0.0080	Waveguide No 11A	
	3.95 GHz to 5.85 GHz	0.0080	Waveguide No 12	
	5.4 GHz to 8.2 GHz	0.0080	Waveguide No 14	
	7.05 GHz to 10.0 GHz	0.0080	Waveguide No 15	
	8.2 GHz to 12.4 GHz	0.0080	Waveguide No 16	
	10.0 GHz to 15.0 GHz	0.0080	Waveguide No 17	
	12.4 GHz to 18.0 GHz	0.0080	Waveguide No 18	
	18.0 GHz to 26.5 GHz	0.0080	Waveguide No 20	
	26.5 GHz to 40.0 GHz	0.0080	Waveguide No 22	
	33.0 GHz to 50.0 GHz	0.013	Waveguide No 23	
	40 GHz to 60 GHz	0.015	Waveguide No 24	
	50 GHz to 75 GHz	0.015	Waveguide No 25	
	75 GHz to 110 GHz	0.015	Waveguide No 27	
7 mm coaxial feed	*1.0 GHz to 1.5 GHz*	0.015	50 Ω Type N connectors	
	1.5 GHz to 18.0 GHz	0.011	50 Ω Type N connectors	
	1.0 GHz to 8.2 GHz	0.013	50 Ω GPC-7 connectors	
	8.2 GHz to 18.0 GHz	0.018	50 Ω GPC-7 connectors	
3.5 mm coaxial feed	*1.0 GHz to 8.2 GHz*	0.010	50 Ω GPC-3.5 connectors	
	8.2 GHz to 18 GHz	0.020	50 Ω GPC-3.5 connectors	
	18.0 GHz to 26.5 GHz	0.029	50 Ω GPC-3.5 connectors	
2.92 mm coaxial feed	*1 GHz to 26.5 GHz*	0.028	50 Ω 2.92 mm connectors	
	26.5 GHz to 40 GHz	0.043	50 Ω 2.92 mm connectors	
2.4 mm coaxial feed	*1 GHz to 26.5 GHz*	0.021	50 Ω 2.4 mm connectors	
	26.5 GHz to 40 GHz	0.041	50 Ω 2.4 mm connectors	
	40 GHz to 50 GHz	0.056	50 Ω 2.4 mm connectors	
			Devices fitted with coaxial connectors other than those listed above may be calibrated but the uncertainties may be increased.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
ANTENNA FACTOR *Service Reference: EF06*	−30 dB/m to +80 dB/m		Calibrations to meet the requirements of ARP 958, ANSI C63.5 (2006 & 2017), CISPR 16-1-6.	Teddington
Linear dipole	20 MHz to 500 MHz 500 MHz to 1000 MHz	0.35 dB 0.50 dB	Defined height, tuned element	
Linear dipole	20 MHz to 40 MHz 40 MHz to 1000 MHz	0.70 dB 0.50 dB	Free-space, tuned element	
Biconical antenna	20 MHz to 300 MHz	0.50 dB	Free-space or defined height (vs. SRDs)	
Mini-Biconical antenna	300 MHz to 6 GHz	0.50 dB	Free-space	
LPDA antenna	80 MHz to 200 MHz	0.70 dB	Free-space	
LPDA antenna	200 MHz to 6 GHz	0.50 dB	Free-space	
Biconical, Hybrid and LPDA	30 MHz to 1 GHz	1.0 dB	Standard Site method, horizontal (ANSI C63.5 2006 & 2017)	
Hybrid antenna	20 MHz to 6 GHz	0.70 dB	Free-space	
Spiral antenna	100 MHz to 1 GHz	1.0 dB	Free-space	
Horn antenna	200 MHz to 2 GHz	1.0 dB	Free-space	
Rod antenna *Service Reference: EF11*	100 Hz to 100 MHz	1.0 dB 1.2 dB	Plane wave E-field ECSM	
DUAL ANTENNA FACTOR *Service Reference: EF06*			For use in NSA measurements	
Biconical, LPDA and hybrid antennas	30 MHz to 1000 MHz	1.0 dB	Standard Site method, horizontal polarisation	
Biconical, LPDA and hybrid antennas	30 MHz to 1000 MHz	1.5 dB	Standard Site method, vertical polarisation	
RADIATION PATTERNS *Service Reference: EF13*	Gain < +10 dBi			
	500 MHz to 18 GHz	0.35 dB	From 0 dB to -6 dB, relative to maximum level.	
	500 MHz to 18 GHz	1.0 dB	From -6 dB to -15 dB, relative to maximum level.	
	Note: other parameters may be derived from pattern data, such as Directivity and Efficiency. The uncertainty is related to the change in gain relative to its maximum value.			
REFLECTION COEFFICIENT *Service Reference: EF06*	Gamma: 0 to 1 0.3 MHz to 6 GHz	0.05	50 Ω Type N connectors. AUTs with other coaxial connectors can be calibrated but the uncertainty may be increased.	
Antenna Balance (Symmetry)	30 MHz to 300 MHz For values within ± 2 dB	0.25 dB	ANSI C 63.5 (2006 & 2017) and CISPR 16-1-4	
VSWR (Derived from S11)	0.3 MHz to 6 GHz For VSWR value = 1.2 to 3	0.02 to 0.2	Uncertainty will be increased for VSWR > 3	
E-field emitters	30 MHz to 6 GHz 10 kHz to 6 GHz	1.5 dB 1.0 dB	Radiated, depends on SNR Conducted	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
ATTENUATION *Service Reference EG03*				**Teddington**
Coaxial Line	0 dB to 100 dB *0.5 MHz to 18 GHz*	(0.00060 dB per 10 dB) + 0.00060 dB	50 Ω 14 mm Coaxial Line (GR-900 connector) up to 8.0 GHz.	
	100 dB to 120 dB *0.5 MHz to 100 MHz*	0.00080 dB per 10 dB	50 Ω 7 mm Coaxial Line: Standard N-Type connector up to 12.4 GHz; Precision N-type and GPC-7 connectors to 18 GHz.	
	120 dB to 130 dB *0.5 MHz to 100 MHz*	(0.0010 dB per 10 dB) + 0.010 dB	3.5 mm Coaxial Line up to 26.5 GHz (GPC-3.5 connectors)	
	0 dB to 80 dB *18 GHz to 40 GHz*	(0.00060 dB per 10 dB) + 0.00060 dB	2.92 mm Coaxial Line up to 40 GHz (K connector).	
			2.4 mm Coaxial Line up to 40 GHz (2.4 mm connector).	
Waveguide	0 dB to 90 dB			
	2.6 GHz to 3.95 GHz *3.3 GHz to 4.9 GHz* *3.95 GHz to 5.85 GHz* *5.85 GHz to 8.2 GHz* *7.05 GHz to 10.0 GHz* *8.2 GHz to 12.4 GHz* *10.0 GHz to 15.0 GHz* *12.4 GHz to 18.0 GHz*	(0.00060 dB per 10 dB) + 0.00060 dB	Waveguide No 10 Waveguide No 11A Waveguide No 12 Waveguide No 14 Waveguide No 15 Waveguide No 16 Waveguide No 17 Waveguide No 18	
	0 dB to 80 dB			
	18 GHz to 26.5 GHz *26.5 GHz to 40 GHz*	(0.00060 dB per 10 dB) + 0.00060 dB	Waveguide No 20 Waveguide No 22	
			NOTE The uncertainties for attenuation apply to the measurement of a device that is well matched to the ideal characteristic impedance of the transmission line system. The quoted uncertainty will be increased for other devices to account for mismatch and repeatability, when these contributions exceed that which has been allowed for in this schedule.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
RF POWER *Service Reference EG04* Calibration factor and effective efficiency - guided wave systems	0.1 mW to 10 mW *8.2 GHz to 12.4 GHz* *12.4 GHz to 18.0 GHz* *18.0 GHz to 26.5 GHz* *26.5 GHz to 40.0 GHz* *40 GHz to 50 GHz* *50.0 GHz to 75 GHz* *75 GHz to 110.0 GHz*	 0.40 % 0.40 % 0.50 % 0.50 % 0.90 % 1.2 % 1.6 %	 Waveguide No 16 Waveguide No 18 Waveguide No 20 Waveguide No 22 Waveguide No 23 Waveguide No 25 Waveguide No 27	**Teddington**
RF POWER Calibration factor and effective efficiency - coaxial line systems	Nominal power range 0.01 mW to 10 mW *10 MHz to 100 MHz* *100 MHz to 4 GHz* *4 GHz to 8 GHz* *8 GHz to 12 GHz* *12 GHz to 15 GHz* *15 GHz to 18 GHz*	 0.25 % 0.40 % 0.45 % 0.55 % 0.60 % 0.70 %	 Calibration of 7mm power sensors and thermistor mounts against the NPL 7 mm calorimeter. The uncertainties apply to devices with type N connectors with VRC less than 0.01 in a 50 Ω coaxial system. The uncertainties may be increased for devices with a higher VRC or fitted with other connector types.	
COMPLEX REFLECTION COEFFICIENT (in support of attenuation and Power calibrations)				
Magnitude	0 to 1.0 *2.6 GHz to 3.95 GHz* *3.3 GHz to 4.9 GHz* *3.95 GHz to 5.85 GHz* *5.85 GHz to 8.2 GHz* *7.05 GHz to 10.0 GHz* *8.2 GHz to 12.4 GHz* *10.0 GHz to 15.0 GHz* *12.4 GHz to 18.0 GHz* *18.0 GHz to 26.5 GHz* *26.5 GHz to 40.0 GHz* *40.0 GHz to 50 GHz* *60.0 GHz to 62 GHz* *75 GHz to 110 GHz* *10 MHz to 18 GHz* *10 MHz to 26.5 GHz*	 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0040 0.0050	 Waveguide No 10 Waveguide No 11A Waveguide No 12 Waveguide No 14 Waveguide No 15 Waveguide No 16 Waveguide No 17 Waveguide No 18 Waveguide No 20 Waveguide No 22 Waveguide No 23 Waveguide No 25 Waveguide No27 50 Ω APC-7 or Type N Connectors 50 Ω 3.5 mm connectors	
Phase	-180° to +180° *Frequency range as for magnitude*	$\sin^{-1}\frac{(\text{magnitude uncertainty})}{\text{magnitude}}$°	If the magnitude is less than its uncertainty, then the phase uncertainty is 180°	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
PULSE CHARACTERISTICS				Teddington
Service Reference EU01				
Transition Duration	11 ps to 60 ps 60 ps to 10 ns	0.90 ps 0.50 % + 1.4 ps	Calibration of pulse generators	
Pulse Amplitude	50 mV to 800 mV 800 mV to 1 V	0.30 % 0.50 %		
Pulse Aberrations (e.g. pre-shoot, overshoot, pulse settling error)	Pulse settling error Others	0.050 % of amplitude 0.10 % of amplitude	The quoted uncertainty will depend on the measurement bandwidth and the type and position of the aberration. Generally, the assigned uncertainty will not be larger than 1 %.	
TIME AND FREQUENCY				
Service Reference TT02/TT04				
Characterisation of GPS disciplined oscillators and frequency standards				
Time offset Time offset	From UTC (NPL) From UTC	2.0 ns 10 ns		
Frequency	5 MHz and 10 MHz	5.0×10^{-14} *Minimum measurement period 24 hours*.	Calibration of frequency standards with a 1 pps output can also be undertaken.	
Time delay (coaxial cables)	0 ns to 300 ns	1.0 ns	For cable characterisation in support of GPSDO calibration.	
Remote characterisation of GPS disciplined oscillators and frequency standards			The capability relates to a remote common-view service where NPL-supplied software gathers data and returns it to NPL for processing. The user is supplied with instructions for the setting up of the equipment and the antenna. Calibration of frequency standards with a 1 pps output can also be undertaken.	Customers' sites
Time offset	Weekly values relative to UTC (NPL)	20 ns		
Time offset	Weekly values relative to estimated UTC	40 ns		
Time offset	Post-processed values relative to corrected UTC data	10 ns		
Frequency	5 MHz and 10 MHz	1.0×10^{-13} *Minimum measurement period 24 hours.*		

Primary Impedance Measurement System *(PIMMS)*
Service Reference EG02 / EG06

NOTE

For the linear voltage reflection and transmission coefficient measurands (i.e. complex-valued *S*-parameters) described in this section of the Schedule, the uncertainty is shown as an interval of values, where a selected value within the interval represents an expanded uncertainty at a level of confidence of approximately 95%. Furthermore, a selected value within the interval will represent the uncertainty applied equally and simultaneously to *both* the Real and Imaginary parts of the *S*-parameter. The uncertainty value therefore defines a circular region of uncertainty, in the appropriate complex *S*-parameter plane, centred on the measured, quoted, mean value with radius equal to the stated expanded uncertainty. The corresponding *k* value will not be less than 2.5.

For Voltage Reflection Coefficients (VRCs), the stated uncertainty is assumed here to be independent of the nominal |VRC|, so a single interval is presented applicable for all |VRC| in the range $0 \le |VRC| \le 1$. For Voltage Transmission Coefficients (VTCs), the stated uncertainty is dependent on the nominal |VTC|, so uncertainty intervals are presented for selected, representative, values of |VTC| in the range, $0 \le |VTC| \le 1$.

Voltage Reflection Coefficient Magnitude (|VRC|) in 50 Ω coaxial systems

Connector Type	|VRC|	Frequency (GHz)															
		0.01	0.02	0.04	0.045	0.05	0.07	0.09	0.1	0.2	0.3	0.5	1.0	1 to 7.5	7.5 to 8.5	8.5 to 18	18 to 26.5
7-16	0 to 0.5				0.002	0.002	0.002	0.002	0.002	0.002	0.0015	0.0015	0.001	0.001			
7-16	0.5 to 0.7				0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.002	0.002	0.002	0.002			
7-16	0.8				0.003	0.003	0.003	0.003	0.003	0.003	0.0025	0.0025	0.0025	0.0025			
7-16	0.9				0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.003	0.003	0.003	0.003			
7-16	1.0				0.004	0.004	0.004	0.004	0.004	0.004	0.0035	0.0035	0.0035	0.0035			
GR900	0 to 0.5				0.002	0.002	0.002	0.002	0.002	0.002	0.0015	0.0015	0.001	0.001	0.001		
GR900	0.5 to 0.7				0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.002	0.002	0.002	0.002	0.002		
GR900	0.8				0.003	0.003	0.003	0.003	0.003	0.003	0.0025	0.0025	0.0025	0.0025	0.0025		
GR900	0.9				0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.003	0.003	0.003	0.003	0.003		
GR900	1.0				0.004	0.004	0.004	0.004	0.004	0.004	0.0035	0.0035	0.0035	0.0035	0.0035		
GPC-7	0 to 0.6	0.0055	0.0045	0.004	0.004	0.004	0.004	0.0035	0.0035	0.0035	0.003	0.003	0.0025	0.0025	0.0025	0.0025	
GPC-7	0.6 to 0.8	0.0055	0.005	0.0045	0.0045	0.0045	0.0045	0.004	0.004	0.004	0.0035	0.0035	0.003	0.003	0.003	0.003	
GPC-7	0.9	0.006	0.0055	0.005	0.005	0.005	0.005	0.0045	0.0045	0.0045	0.004	0.004	0.004	0.0035	0.0035	0.0035	
GPC-7	1.0	0.0065	0.0055	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.0045	0.0045	0.0045	0.004	0.004	0.004	
Type-N	0 to 0.6	0.0055	0.0045	0.004	0.004	0.004	0.004	0.0035	0.0035	0.0035	0.003	0.003	0.0025	0.0025	0.0025	0.0025	
Type-N	0.6 to 0.8	0.0055	0.005	0.0045	0.0045	0.0045	0.0045	0.004	0.004	0.004	0.0035	0.0035	0.003	0.003	0.003	0.003	
Type-N	0.9	0.006	0.0055	0.005	0.005	0.005	0.005	0.0045	0.0045	0.0045	0.004	0.004	0.004	0.0035	0.0035	0.0035	
Type-N	1.0	0.0065	0.0055	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.0045	0.0045	0.0045	0.004	0.004	0.004	
3.5 mm	0 to 0.8				0.01	0.0095	0.009	0.0085	0.008	0.007	0.007	0.0065	0.006	0.005	0.005	0.005	0.005
3.5 mm	0.8 to 1.0				0.01	0.01	0.0095	0.009	0.0085	0.0075	0.0075	0.007	0.0065	0.0055	0.0055	0.0055	0.0055

Location Code: **Teddington**

Primary Impedance Measurement System *(PIMMS)* (continued)

Voltage Reflection Coefficient Magnitude (|VRC|) in waveguide systems

Waveguide size	Frequency (GHz)				
	5.4 to 8.2	8.2 to 12.4	12.4 to 18	18 to 26.5	26.5 to 40
R70	0.001				
R100		0.001			
R140			0.0015		
R220				0.0015	
R320					0.003

Voltage Transmission Coefficient Magnitude (|VTC|) in 50 Ω coaxial systems

Connector Type	|VTC| and corresponding insertion loss (dB)	Frequency	Minimum uncertainty (VTC)
7-16	1 (0 dB)	10 MHz to 7.5 GHz	0.00040
7-16	0.316 (10 dB)	10 MHz to 7.5 GHz	0.00035
7-16	0.1 (20 dB)	10 MHz to 7.5 GHz	0.00020
7-16	0.0316 (30 dB)	10 MHz to 7.5 GHz	0.00010
7-16	0.01 (40 dB)	10 MHz 100 MHz	0.00010
7-16	0.01 (40 dB)	100 MHz to 7.5 GHz	0.00005
7-16	0.00316 (50 dB)	10 MHz to 100 MHz	0.00010
7-16	0.00316 (50 dB)	100 MHz to 7.5 GHz	0.00004
14 mm	1 (0 dB)	45 MHz to 8.5 GHz	0.00040
14 mm	0.316 (10 dB)	45 MHz to 8.5 GHz	0.00035
14 mm	0.1 (20 dB)	45 MHz to 8.5 GHz	0.00020
14 mm	0.0316 (30 dB)	45 MHz to 8.5 GHz	0.00010
14 mm	0.01 (40 dB)	45 MHz 100 MHz	0.00010
14 mm	0.01 (40 dB)	100 MHz to 8.5 GHz	0.00005
14 mm	0.00316 (50 dB)	45 MHz to 100 MHz	0.00010
14 mm	0.00316 (50 dB)	100 MHz to 8.5 GHz	0.00004
Type-N	1 (0 dB)	10 MHz to 18 GHz	0.00040
Type-N	0.316 (10 dB)	10 MHz to 18 GHz	0.00035
Type-N	0.1 (20 dB)	10 MHz to 18 GHz	0.00020
Type-N	0.0316 (30 dB)	10 MHz to 18 GHz	0.00010
Type-N	0.01 (40 dB)	10 MHz to 100 MHz	0.00010
Type-N	0.01 (40 dB)	100 MHz to 18 GHz	0.00005
Type-N	0.00316 (50 dB)	10 MHz to 100 MHz	0.00010
Type-N	0.00316 (50 dB)	100 MHz to 18 GHz	0.00004
3.5 mm	1 (0 dB)	45 MHz to 26.5 GHz	0.0010
3.5 mm	0.316 (10 dB)	45 MHz to 26.5 GHz	0.00040
3.5 mm	0.1 (20 dB)	45 MHz to 100 MHz	0.00025
3.5 mm	0.1 (20 dB)	100 MHz to 26.5 GHz	0.00020
3.5 mm	0.0316 (30 dB)	45 MHz to 100 MHz	0.00015
3.5 mm	0.0316 (30 dB)	100 MHz to 26.5 GHz	0.00010
3.5 mm	0.01 (40 dB)	45 MHz to 100 MHz	0.00006
3.5 mm	0.01 (40 dB)	100 MHz to 26.5 GHz	0.00005
3.5 mm	0.00316 (50 dB)	45 MHz to 100 MHz	0.00010
3.5 mm	0.00316 (50 dB)	100 MHz to 26.5 GHz	0.00004

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
				Teddington

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
Primary Impedance Measurement System *(PIMMS)* (continued)				Teddington
Voltage Transmission Coefficient Magnitude (|VTC|) in waveguide systems				
Waveguide size	|VTC| and corresponding insertion loss (dB)	Frequency	Minimum uncertainty (VTC)	
R100	1 (0 dB)	8.2 GHz to 12.4 GHz	0.0010	
R100	0.316 (10 dB)	8.2 GHz to 12.4 GHz	0.00040	
R100	0.1 (20 dB)	8.2 GHz to 12.4 GHz	0.00020	
R100	0.0316 (30 dB)	8.2 GHz to 12.4 GHz	0.00010	
R100	0.01 (40 dB)	8.2 GHz to 12.4 GHz	0.00006	
R100	0.00316 (50 dB)	8.2 GHz to 12.4 GHz	0.00004	
R140	1 (0 dB)	12.4 GHz to 18 GHz	0.0025	
R140	0.316 (10 dB)	12.4 GHz to 18 GHz	0.00075	
R140	0.1 (20 dB)	12.4 GHz to 18 GHz	0.00030	
R140	0.0316 (30 dB)	12.4 GHz to 18 GHz	0.00010	
R140	0.01 (40 dB)	12.4 GHz to 18 GHz	0.00006	
R140	0.00316 (50 dB)	12.4 GHz to 18 GHz	0.00004	
R220	1 (0 dB)	18 GHz to 26.5 GHz	0.0030	
R220	0.316 (10 dB)	18 GHz to 26.5 GHz	0.00075	
R220	0.1 (20 dB)	18 GHz to 26.5 GHz	0.00030	
R220	0.0316 (30 dB)	18 GHz to 26.5 GHz	0.00010	
R220	0.01 (40 dB)	18 GHz to 26.5 GHz	0.00006	
R220	0.00316 (50 dB)	18 GHz to 26.5 GHz	0.00004	
R320	1 (0 dB)	26.5 GHz to 40 GHz	0.0030	
R320	0.316 (10 dB)	26.5 GHz to 40 GHz	0.00075	
R320	0.1 (20 dB)	26.5 GHz to 40 GHz	0.00030	
R320	0.0316 (30 dB)	26.5 GHz to 40 GHz	0.00010	
R320	0.01 (40 dB)	26.5 GHz to 40 GHz	0.00006	
R320	0.00316 (50 dB)	26.5 GHz to 40 GHz	0.00004	
Mechanically-derived characteristic impedance of the following coaxial lines:				
7-16	49.8 Ω to 50.2 Ω	0.009 Ω	Based on measurements of the diameters of airline conductors, these and associated uncertainties will also be reported. These measurements are made using air gauging techniques.	
14 mm	49.8 Ω to 50.2 Ω	0.010 Ω		
Type-N	27.7 Ω to 28.3 Ω	0.018 Ω		
Type-N or GPC-7	49.6 Ω to 50.4 Ω	0.016 Ω		
Type-N	74.4 Ω to 75.6 Ω	0.031 Ω		
Type-N	99.2 Ω to 100.8 Ω	0.078 Ω		
3.5 mm	49.2 Ω to 50.8 Ω	0.038 Ω		
2.92 mm	48.9 Ω to 50.9 Ω	0.048 Ω		
2.4 mm	48.9 Ω to 51.4 Ω	0.063 Ω		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
LENGTH				**Teddington**
Gauge blocks: millimetre *Service Reference: LD01*	As BS EN ISO 3650:1999 0.5 mm to 25 mm 25 mm to 50 mm 50 mm to 75 mm 75 mm to 100 mm	0.020 μm 0.020 μm to 0.022 μm 0.022 μm to 0.025 μm 0.025 μm to 0.029 μm	Measurement of central length by interferometry. Measured twice, wrung to a platen by each of the two measuring faces in turn, and the mean of these two measurements stated on the certificate.	
Gauge blocks: inch *Service Reference: LD01*	As BS 4311:2007 0.01 in to 0.4 in 0.4 in to 1 in 2 in 3 in 4 in	0.76 μ inch 0.76 μ inch to 0.78 μ inch 0.86 μ inch 0.98 μ inch 1.14 μ inch		
Gauge blocks: millimetre *Service Reference: LD01*	As BS EN ISO 3650:1999 0.5 mm to 10 mm 10 mm to 25 mm 25 mm to 50 mm 50 mm to 75 mm 75 mm to 100 mm	0.032 μm to 0.033 μm 0.033 μm to 0.037 μm 0.037 μm to 0.050 μm 0.050 μm to 0.065 μm 0.065 μm to 0.082 μm	Measurement of central length by mechanical comparison.	
Gauge blocks: inch *Service Reference: LD01*	As BS 4311:2007 0.01 to 0.4 in 0.4 in to 1 in 2 in 3 in 4 in	1.26 to 1.30 μ inch 1.30 to 1.47 μ inch 1.97 μ inch 2.60 μ inch 3.29 μ inch		
1-D artefacts [Long gauge blocks and length bars]: length millimetre (and inch) *Service Reference: LD02*	As BS EN ISO 3650:1999 Grades K, 0 and 1; As BS 5317:1976 Reference and calibration grades 100 mm to 1200 mm	Q[0.00012, 1.4 × 10^{-7}L] mm	Measurement of length by CMM substitution method of gauges of length L (in mm) .	
1-D artefacts [Long gauge blocks and length bars]: length millimetre (and inch) *Service Reference: LD02*	As BS EN ISO 3650:1999 Grades K, 0 and 1; As BS 5317:1976 Reference and calibration grades 100 mm to 1200 mm	Q[0.00041, 2.0 x 10^{-6}L] mm	Measurement of length by CMM method of gauges of length L (in mm) .	
Long gauge blocks: millimetre *Service Reference: LD05*	As BS EN ISO 3650:1999 Grades K, 0 and 1 100 mm to 1000 mm As BS EN ISO 3650:1999 Grades K, 0 and 1 100 mm to 1000 mm	$\sqrt{0.049^2 + (0.083 \times L)^2}$ μm i.e., 0.050 μm to 0.100 μm 0.116 + (0.263 x L) μm i.e., 0.143 to 0.379 μm	Measurement of length by absolute interferometry of long gauge blocks of length L (in metres) to the stated standards. Measurement of length by interferometric comparison of long gauge blocks of length L (in metres) to the stated standards.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$)	Remarks	Location Code
LENGTH (continued)				Teddington
Length bars: millimetre *Service Reference: LD02*	As BS 5317:1976; Reference and calibration grades			
	10 mm to 100 mm	$\sqrt{0.060^2 + (0.21 \times L)^2}$ μm i.e. 0.061 μm to 0.064 μm		
	100 mm to 1200 mm	$\sqrt{0.049^2 + (0.083 \times L)^2}$ μm i.e. 0.050 μm to 0.111 μm		
	Above 100 mm up to 1200 mm	0.116 + (0.263 x L) μm i.e. 0.143 to 0.432 μm	Measurement of length by interferometric comparison of length bars of length *L* (in metres) to the stated standards.	
Length bars: Inch *Service Reference: LD05*	As BS 1790:1961; Reference and calibration grades			
	0.5 in to 4 in	$\sqrt{2.36^2 + (0.21 \times L)^2}$ μ inch i.e. 2.40 μ inch to 2.53 μ inch	Measurement of length by absolute interferometry of length bars of length *L* (in inches) to the stated standards.	
	4 in to 48 in	$\sqrt{1.9^2 + (0.083 \times L)^2}$ μ inch i.e. 1.93 μ inch to 4.42 μ inch		
	4 in to 48 in	4.57 + (0.263 x *L*) μ inch i.e. 5.62 μ inch to 17.2 μ inch	Measurement of length by interferometric comparison of long gauge blocks of length *L* (in inches) to the stated standards.	
Thermal expansion coefficient at 20 °C *Service Reference: LD03*	Expansion coefficient 9 x 10^{-6} K^{-1} to 13 x 10^{-6} K^{-1}	(0.004 + 11/*L* + 0.000 007*L*) x 10^{-6} K^{-1}, where *L* is length of gauge block or length bar in millimetres.	The uncertainty applies to the measurement of the linear coefficient of thermal expansion, at 20 °C, of long series gauge blocks and length bars above 100 mm, up to 1200 mm (4 inch to 48 inch) which comply with the following standards: Reference and calibration grades of BS 1790:1961 (inch). Reference and calibration grades of BS 5317:1976 (millimetre). Grades K, 0 of ISO 3650:1998.	
Step gauges *Service Reference: LD04*	210 mm to 1020 mm	(100+ 232 *L*) nm, where *L* is length in metres		
Thread measuring cylinders *Service Reference: LD07*	0.05 mm to 5 mm diameter	0.080 + (0.0010 x diameter in mm) μm	As BS 3777:1964 BS 5590:1978 and specials	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
LENGTH (continued)				**Teddington**
External cylinder Plain plug gauges (parallel) reference cylinders and rollers *Service Reference: LD07*	0.1 mm to 100 mm diameter 100 mm to 150 mm diameter	0.070 + (0.0011 x diameter in mm) μm 0.05 + (0.0014 x diameter in mm) μm		
Plain setting rings (parallel) *Service Reference: LD07*	3 mm to 250 mm diameter	0.070 + (0.0005 x diameter in mm) μm	As BS 4064:1966 and BS 4065:1966 Grade AA, and equivalent quality setting rings	
Stage micrometers and graticules *Service Reference: LR04*	0 mm to 50 mm 50mm to 100mm 100mm to 150mm	0.20 μm 0.30 μm 0.40 μm		
Linewidth standards *Service Reference: LR03*	0.5 μm to 10 μm 10 μm to 50 μm	0.050 μm 0.10 μm		
Reference stage graticules for image analysers *Service Reference: LR07*	Grid sizes 0 to 400 μm x 400 μm Spot sizes 3 μm to 48 μm	0.10 μm 0.10 μm		
Reference master screw plug and ring gauges (taper) to API specifications 5B and 7 *Service Reference: LD06*	0 in to 20 in diameter	Pitch diameters 0.00037 in Major diameter 0.0002 in Minor diameter 0.0006 in Pitch 0.00012 in Taper 0.00011 in Flank angle 3.0 minutes of arc Stand off 0.00034 in		
Receiver and position gauges, jigs and fixtures *Service Reference: LD10*	1200 x 1000 x 700	0.36 + L/866 µm, where L is in mm 0.70 µm (using substitution method) 0.40 µm (using reversal method)	Measurements made using a coordinate measuring machine	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
ANGLE *Service Reference: LD08*				**Teddington**
Indexing tables	From 0° to 360°	0.040 seconds of arc		
Precision polygons	4 sides to 12 sides, excluding 7 and 11 sides	0.11 seconds of arc		
Combination angle gauges	0° to 45°	0.30 seconds of arc	As MOY/SCMI/18 and MOY/SCMI/45	
Autocollimators *Visual and photoelectric*	0 minutes of arc to 10 minutes of arc	0.060 seconds of arc		
FORM *Service Reference: LD07*				
Roundness reference standards	0 mm to 100 mm diameter	0.0050 μm		
Reference Sphere Diameter	10 mm to 50 mm diameter	0.11 μm		
Back vertex focal length or power of a lens. *Service Reference: LR02*	± 0.01 D to ± 25 D	0.0010 D to 0.010 D	Zygo interferometer and Hewlett Packard length measuring interferometer traceable to dimensional standards used to measure vertex of the back surface of a lens to the corresponding focus.	
Radius of curvature and sphericity of optical quality surfaces. *Service Reference: LR02*	4 mm to 1000 mm radius of curvature.	0.0020 mm, 26 nm for sphericity.	Test items are calibrated for radius of curvature and departure from spherical form using a Mark GPIxps Zygo interferometer in conjunction with a commercial laser length measuring interferometer.	
Power of small angle prisms. *Service Reference: LR02*	0 to 20 prism dioptres (0° to 12° deviation).	0.010 prism dioptres.	Measurements of small angle prisms are carried out using the a Mark GPIxps Zygo interferometer, auxiliary mirrors, a Hilger and Watts clinometer and calibration test pieces when necessary.	
Optical flatness *Service Reference: LR01*	5 mm to 150 mm OD. 5 to 33mm 33 to 100mm 100 to 150mm	 14 nm 17 nm 20 nm	Flatness of optical quality surfaces using a Zygo Mark GPIxps interferometer housing a reference flat traceable to a liquid surface.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
OTHER MEASURING INSTRUMENTS, EQUIPMENT AND MACHINES				**Teddington**
Laser frequency (Vacuum wavelength) *Service Reference: LL01*	Nominal wavelengths 500 nm to 2.0 μm	1 part in 10^{13}		
Laser interferometer systems *Service Reference: LL01*	0 to 45 m			
	Compensated	$\sqrt{0.08^2 + (0.2 \times L)^2}$ μm	L = length (m)	
	Uncompensated	$\sqrt{0.08^2 + (0.12 \times L)^2}$ μm	L = length (m)	
Extensometer calibration rigs *Service Reference: MF06*	Displacements 0 mm to 1000 mm	31 + (3.1 x R) nm where R is the extension in mm	As BS EN ISO 9513:2012	
INFRA-RED *Service Reference: OT05*	*Thermal Radiation*	0.0020 (, <0.1) 0.0010 (, >0.9)		
Wavenumber, v for QA checks on mid-IR spectrophotometers	*Nominal Values:* 3060.0 cm^{-1} 2849.5 cm^{-1} 1942.9 cm^{-1} 1601.2 cm^{-1} 1583.0 cm^{-1} 1154.5 cm^{-1} 1028.3 cm^{-1}	 0.30 cm^{-1} 0.40 cm^{-1} 0.40 cm^{-1} 0.30 cm^{-1} 0.30 cm^{-1} 0.30 cm^{-1} 0.30 cm^{-1}	Calibrated Artefact: Matt polystyrene film nominally 0.04 mm thick. Each film is individually calibrated at all seven selected transmittance minima. Films are measured in a spectrophotometer with a nominal sample compartment temperature of 30 °C ± 5 °C	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
PHOTOMETRY *Service Reference: OT03*				**Teddington**
Luminous intensity (tungsten lamps)	1 to 100 cd 100 to 1000 cd 1000 to 10000 cd	0.70 % 0.60 % 0.70 %	The actual measurement uncertainty quoted on certificates depends critically on the lamp repeatability or the meter performance. The CMC relates to that which can be achieved using specially designed transfer standards and, in the case of sources, assumes that the correlated colour temperature or spectral power distribution is known. For illuminance/luminance meters, the calibration only applies for a tungsten source at a correlated colour temperature of 2856 K.	
Illuminance (tungsten lamps and illuminance meters)	0.1 to 500 lux 500 to 5000 lux 5000 to 20000 lux 20000 to 50000 lux	0.90 % 0.80 % 0.90 % 1.0 %		
Luminance (tungsten sources and luminance meters)	1 to 100 cd m^{-2} 100 to 1000 cd m^{-2} 1000 to 10000 cd m^{-2}	1.3 % 1.2 % 1.3 %		
Correlated colour temperature (tungsten lamps and colour temperature meters)	2000 to 3200 K	10 K		
Absolute Scale Realisation of Spectral Irradiance				
Luminous flux (tungsten lamps)	1 to 100 lumen 100 to 20000 lumen	0.90 % 0.70 %		
SPECTRORADIOMETRY OF SOURCES *Service Reference: OT03*				
Absolute spectral irradiance of tungsten-based sources	250 nm to 300 nm >300 nm to 400 nm >400 nm to 800 nm >800 nm to 1600 nm >1600 nm to 2400 nm >2400 nm to 2500 nm	1.4 % 1.4 % 0.5 % 0.4 % 0.8 % 1.2 %	Based on measurement against the ultra high temperature blackbody (UHTBB) and applicable to test lamps operating at approximately 2800 K to approximately 3250 K only. Nominal lamp power ratings in the range 500 W – 5,000 W. Includes the calculation of chromaticity coordinates and correlated colour temperature.	
Relative spectral power distribution and absolute spectral irradiance of tungsten and tungsten halogen sources	250 nm to 300 nm >300 nm to 400 nm >400 nm to 800 nm >800 nm to 1600 nm >1600 nm to 2400 nm >2400 nm to 2500 nm	2.1 % 1.8 % 1.1 % 1.0% 1.3% 2.0%	For lamps rated 50 W to 5000 W (nominal), correlated colour temperature in the range 2600 K to 3250 K. Includes the calculation of chromaticity coordinates and correlated colour temperature. Note Calibration measurement capability is based on measurement against “primary” level standards and is applicable to test lamps operating at approximately 2856 K and approximately 3100 K only.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
SPECTRORADIOMETRY OF SOURCES (continued)				
Relative and absolute spectral radiance of tungsten and tungsten halogen based sources	300 nm to 400 nm 400 nm to 800 nm 800 nm to 1600 nm 1600 nm to 2500 nm	3.5 % to 2.7 % 2.7 % to 1.8 % 1.8 % to 2.1 % 2.1 % to 3.0 %	For lamps rated 50 W to 5000 W (nominal), correlated colour temperature in the range 2600 K to 3250 K.	
RADIOMETRY *Service Reference: OT12*				
Spectral responsivity of laser power meters	100 pW to 1 mW *350 nm to 1600 nm*	0.040 %	At laser wavelength or peak wavelength of bandpass filter.	
Spectral responsivity	200 nm to 240 nm 240 nm to 380 nm 380 nm to 405 nm 405 nm to 920 nm 920 nm to 1800 nm	1.0 % 0.80 % 0.30 % 0.10 % 0.30 %		
COLORIMETRY AND SPECTROPHOTOMETRY - REGULAR TRANSMITTANCE *Service Reference: OT05*				
Regular transmittance	0.001 %T to 100 %T *Wavelength range (nm):* $200 \le \lambda \le 210$ $210 < \lambda \le 310$ $310 < \lambda \le 800$ $800 < \lambda \le 3000$	Absolute uncertainty for 90 %T, 60 %T and 0.001 %T: 0.50 %, 0.30 % and 0.000027 % 0.30 %, 0.15 % and 0.000018 % 0.30 %, 0.15 % and 0.000011 % 0.30 %, 0.30 % and 0.000022 %		**Teddington**
Optical density	0 D to 5.0 D *Wavelength range (nm):* $200 \le \lambda \le 210$ $210 < \lambda \le 310$ $310 < \lambda \le 800$ $800 < \lambda \le 3000$	Absolute uncertainty for 0.05 D, 0.22 D and 5.0 D: 0.0024 D, 0.0022 D and 0.012 D 0.0014 D, 0.0011 D and 0.0077 D 0.0014 D, 0.0011 D and 0.0048 D 0.0014 D, 0.0022 D and 0.0097 D	Optical density is equivalent to absorbance (A) and is calculated from regular transmittance using the formula $D = \log_{10} (100/\%T)$.	
Wavelength of absorption peaks	200 to 3000 nm	0.10 nm		
Colour data: CIELAB L* a* b*	 0 to 100 - 200 to + 200 - 200 to + 200	 0.050 0.050 0.050	Colour data is normally given for the CIE 2° and 10° observers and CIE Standard Illuminants A, C and D65. Other Standard Illuminants on request.	
Colour data: CIE x, y, u', v'	0 to 1	0.00020		
Luminous transmittance Y	0 %Y to 100 %Y	0.15 % for 60 %Y		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
COLORIMETRY AND SPECTROPHOTOMETRY - DIFFUSE REFLECTANCE *Service Reference: OT04*				**Teddington**
Spectral diffuse reflectance; specular included and specular excluded geometries	0 %R to 100 %R *Wavelength range (nm):* *200 ≤ λ ≤ 315* *315 < λ ≤ 460* *460 < λ ≤ 800* *800 < λ ≤ 2000* *2000 < λ ≤ 2500*	Absolute uncertainty: 1.6 % for white, 0.60 % for black (0.050 + 0.0055R) % (0.050 + 0.0035R) % 1.6 % for white, 0.35 % for black 2.1 % for white, 0.65 % for black	The CMCs are for measurement against similar NPL masters, and examples are given covering the range from 'white' samples to 'black' samples. Higher uncertainties may apply where no similar master exists.	
Spectral radiance factor (see Notes 1 and 2)	0% to 102%R *Wavelength range (nm):* *200 ≤ λ ≤ 315* *315 < λ ≤ 800* *800 < λ ≤ 2000* *2000 < λ ≤ 2500*	Absolute uncertainty: 1.6 % for white, 0.60 % for black (0.050 + 0.0070R) % 2.3 % for white, 0.30 % for black 2.8 % for white, 0.70 % for black	Radiance factor results are expressed relative to the perfect reflecting (lambertian) diffuser. A result >100 % implies that the sample reflects more radiation at 45° than a lambertian diffuser. See also the remark above.	
Colour data: CIELAB L* a* b*	 0 to 100 - 200 to + 200 - 200 to + 200	 0.15 0.10 0.10	Colour data is normally given for the CIE 2° and 10° observers and CIE Standard Illuminants A, C and D65. Other Standard Illuminants on request.	
Colour data: CIE x, y, u', v'	0 to 1	0.00020	Colour data is normally given for the CIE 2° and 10° observers and CIE Standard Illuminants A, C and D65. Other Standard Illuminants on request.	
Luminous transmittance Y	0 %Y to 100 %Y	0.55 % for white, 0.10 % for black		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
TEMPERATURE				Teddington
Standard resistance thermometers, fixed point calibrations *Service Reference: PM02*	-196 °C to 0.01 °C -189.3442 °C -38.8344 °C 0.01°C 0 °C to 29.7646 °C 0 °C to 156.5985 °C 231.928 °C 419.527 °C 0 °C to 419.527 °C 419.527°C to 660.323°C 0°C to 419.527°C 419.527 °C to 660.323 °C 660.323 °C to 961.78 °C	0.0017 °C to 0.00016 °C 0.00050 °C 0.00035 °C 0.00011°C 0.00016 °C to 0.00030 °C 0.00030 °C to 0.00070 °C 0.00070 °C 0.00090 °C 0.0010 °C 0.0010 °C to 0.0025°C 0.0020°C 0.0020°C to 0.0030 °C 0.0040 °C	Comparison at LN_2. Calibrations at measurement current For HTSPRTs	
Resistance thermometers, calibration by comparison *Service Reference: PM04*	-196 °C -100 °C to -80 °C -80 °C to 0 °C 0 °C to 30 °C 30 °C to 100 °C	0.0050 °C 0.010 °C 0.0060 °C 0.0030 °C 0.0050 °C	Comparison at LN_2 and in acetone. Oil and water baths	
Resistance thermometers, by dry block calibration *Service Reference: PM04*	50 °C to 150 °C 150 °C to 420 °C	0.040 °C 0.040 °C to 0.10 °C		
Temperature indicators with resistance sensor *Service Reference: PM04*	-196 °C to 420 °C	As for sensor		
Fixed Point Cells *Service Reference: PK01*				
Triple point of Argon	-189.3442 °C	0.0005 °C	Cell compared with NPL reference cell during several realisations of the fixed point temperature using Standard Platinum Resistance Thermometers	
Triple point of Mercury	-38.8344 °C	0.0002 °C		
Melting point of Gallium	29.7646 °C	0.0002 °C		
Freezing point of Indium	156.5985 °C	0.0007 °C		
Freezing point of Tin	231.928 °C	0.0006 °C		
Freezing point of Zinc	419.527 °C	0.0009 °C		
Freezing point of Aluminium	660.323 °C	0.0025 °C		
Freezing point of Silver	961.78 °C	0.004 °C		
Water triple point cells	0.01 °C	0.000070 °C 0.000058 °C	By comparison with 2 cells from NPL reference batch By comparison with 5 cells from NPL reference batch	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
TEMPERATURE (continued)				Teddington
Thermocouples *Service Reference: PM03*				
Noble metal type Pt-Rh	420 °C 962 °C, 1085 °C 1324 °C 1492 °C	0.13 °C 0.21 °C 0.53 °C 0.72 °C	ITS-90 fixed points Secondary fixed point Co-C Secondary fixed point Pd-C derived from ITS-90	
	0 °C to 1100°C 1100 °C to 1330 °C 1330 °C to 1500 °C	0.30 °C 0.30 °C to 0.55 °C 0.55 °C to 0.72 °C	Polynomial interpolation with improved homogeneity	
	1064.18 °C 1554.8 °C 0 °C to 1100 °C with 1100 °C to 1600 °C	0.57 °C 0.85 °C 1.0 °C 1.0 °C to 1.5 °C	Wire Bridge Method Au Pd Interpolation based upon Au and Pd wire bridge measurements	
Pt-Rh (type B only)	1768.2 °C 400 °C to 1100 °C 1100 °C to 1800 °C	1.1 °C 0.3 °C 0.3 °C to 1.2 °C	Wire bridge method Pt Based upon Zn and Ag fixed points and Pt wire bridge	
Thermocouples noble metal type Pt-Pd	420 °C 962 °C, 1085 °C 1324 °C 1492 °C	0.10 °C 0.070 °C 0.53 °C 0.72 °C	ITS-90 fixed points Secondary fixed point Co-C Secondary fixed point Pd-C derived from ITS-90	
	0 °C to 1100 °C 1100 °C to 1330 °C 1100 °C to 1500 °C	0.2 °C 0.2 °C to 0.55 °C 0.2 °C to 0.72 °C	Interpolation	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
TEMPERATURE (continued)				Teddington
Thermocouples, Noble metal type Au-Pt	420 °C, 660 °C, 962 °C	0.050 °C		
	0 °C to 1000 °C	0.050 °C	Where Zn and Ag fixed points used	
Thermocouples, base metal types	-196 °C -80 °C to 0 °C 0 °C to 50 °C 50 °C to 100 °C	0.50 °C 0.10 °C 0.050 °C 0.10 °C	Comparison with LN_2 and in oil and water baths	
Thermocouples, by dry block calibration	50 °C to 700 °C	0.75 °C	Calibration via comparison to the integrated reference PRT of a dry block calibrator	
Temperature indicators with thermocouple sensor *Service Reference: PM04*	-196 °C to +100 °C	As for sensor		
Compensating and extension cables *Service Reference: PM03*	-25 °C to 100 °C	As for base metals thermocouples	By comparison.	
Thermocouple fixed point cells *Service Reference: PK01*				
Cu fixed point cell (freeze)	1084 °C	0.031 °C	Certification of fixed point cells by measurement (with Pt/Pd thermocouples) against NPL National Standard fixed point cells	
Co-C fixed point cell (melt)	1324 °C	0.44 °C		
Pd-C fixed point cell (melt)	1492 °C	0.65 °C		
Disappearing filament pyrometers *Service Reference: PM06*	700 °C to 800 °C 800 °C to 1700 °C 1700 °C to 2800 °C	5.0 °C to 2.0 °C 2.0 °C 2.0 °C to 8.0 °C		
Infrared Thermometers *Service Reference: PM06*	-40 °C to +50 °C 15 °C to 45 °C 50 °C to 260 °C 260 °C to 600 °C 600 °C to 1000 °C 1000 °C to 3000 °C	0.10 °C 0.050 °C 0.10 °C 0.20 °C 0.30 °C 0.050 % of Celsius temperature	Including tympanic thermometers For temperatures above 1324 °C Eutectic Fixed Point can be used	
Blackbody Sources *Service Reference: PM06*	-40 °C to +260 °C 260 °C to 600 °C 600 °C to 1000 °C 962 °C, 1064 °C, 1085 °C 1000 °C to 3000 °C	0.20 °C 0.24 °C 0.30 °C 0.060 °C 0.050 % of Celsius temperature		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
HUMIDITY			The accreditation covers other humidity units directly related to dew-point, e.g. vapour pressure, PPM weight, PPM volume, g/kg etc	Teddington
Dew-point *Service Reference: MH01*	+90 °C to +95 °C +90 °C to +75 °C +75 °C to +60 °C +60 °C to -60 °C -60 °C to -75 °C -75 °C to -90 °C	0.10 °C to 0.12 °C 0.10 °C to 0.050 °C 0.050 °C to 0.033 °C 0.033 °C 0.033 °C to 0.10 °C 0.10 °C to 0.50 °C		
Dew point in air and nitrogen at elevated pressure *Service Reference: MH07*	-60 °C to +10 °C	0.070 °C	At pressures up to 1 MPa	
Dew point in various gases at elevated pressure *Service Reference: MH07*	-60 °C to +15 °C 1 µmol/mol to 100 µmol/mol	0.12 °C 0.04 µmol/mol to 1.25 µmol/mol	At pressures up to 3 MPa in air, inert gases, methane and premade cylinder gas blends	
Relative Humidity *Service Reference: MH02/MH03*	0.5 %rh to 98 %rh at temperatures from -40 °C to +100 °C	0.60 % of reading + 0.10 %rh		
Temperature Sensors incorporated in humidity instruments *Service Reference: MH02/MH03*	-40 °C to < -20 °C -20 °C to +50 °C > +50 °C to +100 °C	0.080 °C 0.040 °C 0.080 °C		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
NEUTRON DOSIMETRY				Teddington
NEUTRON SOURCE EMISSION RATE *Service Reference: RN05*				
Emission rate from radionuclide neutron sources	Source emission rate $10^5\ s^{-1}$ to $2 \times 10^9\ s^{-1}$	1.0 % to 1.2 % depending on source	Service reference number: RN05 Induced ^{56}Mn activity measured using sodium iodide detectors	
	Source emission rate $10^2\ s^{-1}$ to $2 \times 10^6\ s^{-1}$	1.2 % to 1.5 % depending on source	Service reference number: RN05 Relative measurement performed using a moderating detector assembly	
Anisotropy of emission from radionuclide neutron sources	Source emission rate $10^5\ s^{-1}$ to $10^8\ s^{-1}$ Anisotropy factor 0.5 to 1.2	1.0 % to 0.50 % depending on source	Service reference number: RN05. Measurements performed using a precision long counter in a low-scatter environment	
NEUTRON FLUENCE				
Thermal neutron fluence *Service Reference: RN01*	Energy: thermal Thermal neutron beam Fluence rates: $10^3\ cm^{-2}\ s^{-1}$ to $4 \times 10^4\ cm^{-2}\ s^{-1}$	1.2 % for Wescott fluence 4.0 % for 'true' fluence	Service reference number: RN01 Fast neutrons moderated in a graphite pile. Beam of thermal neutrons extracted. Fluence standard - gold foil activation Service conforms to ISO Standard 8529 Parts 1 to 3.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
NEUTRON FLUENCE (continued)				
Thermal neutron fluence *Service Reference: RN01*	Energy: thermal Thermal neutrons in cavity -Fluence rates; 10^4 cm^{-2} s^{-1} to 3 x 10^7 cm^{-2} s^{-1}	1.0 % for Westcott fluence	Service reference number: RN01. Fast neutrons moderated in graphite pile. Thermal neutrons in a small 150 cm^3 cavity. Fluence standard - gold foil activation.	Teddington
Fast neutron fluence *Service Reference: RN02*	Energy: 70 keV to 17 MeV Monoenergetic fields Fluence rates: 1 cm^{-2} s^{-1} to 1500 cm^{-2} s^{-1} at 1 m from source	4.0 %	Service reference number: RN02. Neutrons are produced using beams of protons or deuterons from a 3.5 MV Van de Graaff accelerator. Fluences measured using precision long counter. Service conforms to ISO Standard 8529 Parts 1 to 3.	
Fast neutron fluence *Service Reference: RN04*	Energy: broad energy range from sources: ^{241}Am-Be, ^{252}Cf, ^{241}Am-B, ^{241}Am-Li, ^{241}Am-F Fluence rates: 1 cm^{-2} s^{-1} to 400 cm^{-2} s^{-1} at 1 m from source	1.3 %	Service reference number: RN04. Fields are produced using radionuclide neutron sources of known emission rate. Actual fluence rate depends on particular source Service conforms to ISO Standard 8529 Parts 1 to 3.	
NEUTRON DOSE EQUIVALENT				
Thermal and fast neutron dose equivalents *Service Reference: RN01, RN02 & RN04*	Energy: thermal Thermal neutron beam Energy: 70 keV to 17 MeV Monoenergetic fields Energy: broad energy range from radionuclide sources Dose equivalent rates: ^{241}Am-Be: 1 μSv h^{-1} to 400 μSv h^{-1} at 1m from the source ^{252}Cf: 1.6 μSv h^{-1} to 3.2 mSv h^{-1} at 1m from the source	5.0 % 4.0 % 8.1 % 2.4 %	Service reference numbers: RN01, RN02, and RN04. Fluences are converted to ambient dose equivalent or personal dose equivalent using accepted conversion coefficients. For broad energy range neutron fields from sources the uncertainties in the neutron dose equivalent values reflect uncertainties in the source spectra rather than the conversion coefficients, which are assumed to be exact. Service conforms to: ISO 8529 2001 Part 1 and 2. ISO 8529 1998 Part 3.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
NEUTRON DOSE EQUIVALENT (continued)				
Thermal and fast neutron dose equivalents *Service Reference: RN04*	241Am-B: 5 μSv h^{-1} at 1m from the source	8.5%		
	241Am-F: 1.6 μSv h^{-1} at 1m from the source	9.0%		
	241Am-Li: 1.8 μSv h^{-1} at 1m from the source	9.0%		
Fast neutron personal dosemeter proficiency testing *Service Reference: RN04*	Energy: broad energy range from radionuclide sources Dose equivalent rates: ^{241}Am-Be: 1 μSv h^{-1} to 400 μSv h^{-1} at 1m from the source	8.1 %	Service reference number: RN04. In accordance with HSE Measurement Protocol for Performance Testing of Dosimetry Services for External, Whole Body Fast Neutron Radiation, June 2001.	**Teddington**
	^{252}Cf: 1.6 μSv h^{-1} to 3.2Sv h^{-1} at 1m from the source	2.4 %		
<u>Protection level dosemeters</u> Air kerma rate				
X-rays *Service Reference: RD02*	ISO 4037 narrow spectrum (generating potential 8 keV to 250 keV) 350 μGy h^{-1} to 100 mGyh^{-1}	1.5 %	Service reference number: RD02 Calibration of protection level ionisation chamber with volumes ranging from 35 cm^3 to 10 litres connected to a suitable secondary standard electrometer.	
γ-radiation *Service Reference: RD02*	^{60}Co 1 μGyh^{-1} to 0.3 Gyh^{-1} ^{137}Cs 1 μGyh^{-1} to 0.3 Gyh^{-1}	1.2 % 1.2 %		
	^{241}Am 8 μGyh^{-1} to 0.3 mGyh^{-1}	1.5 %		
X-ray generating potential *Service Reference: RD04*	Generating potential 25 kVp to 150 kVp	1.5 %	Service reference number: RD04. Calibration of penetrameters and kVp meters.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
<u>Therapy level dosemeters</u> Measurement of air kerma rate				Teddington
X-rays *Service Reference: RD01*	Half value layers 0.024 mm Al to 20 mm Al (generating potential 8 kVp to 280 kVp)	1.2 %	Service reference number: RD01 Calibration of NE2561, NE2611 and Farmer type and soft x-ray ionisation chambers.	
γ-radiation *Service Reference: RD01*	^{60}Co	1.2 %	Calibration of NE2561, NE2611, for Farmer type ionisation with a suitable secondary standard electrometer, if supplied.	
Measurement of absorbed dose to water				
γ-radiation *Service Reference: RD01*	^{60}Co	1.4 %	Calibration of NE2561, NE2611, for Farmer type ionisation with a suitable secondary standard electrometer, if supplied.	
Photons *Service Reference: RD01*	TPR_{10}^{20}: 0.568 to 0.800 Nominal beam energy ^{60}Co, 4-25MV	1.4 %		
Electrometer (charge) *Service Reference: RD16*	10 pC to 1 μC	0.1% to 0.9%	Service reference number RD16: Calibration of suitable secondary standard electrometer	
Electrometer (charge) *Service Reference: RD16*	10pA to 2 μA	0.1 % to 0.9%	Service reference number RD16: Calibration of suitable secondary standard electrometer	
<u>High dose dosimetry</u>				
Absorbed dose to water *Service Reference: RD07*	^{60}Co Dose: >2 Gy	2.2 %	Service reference number: RD07 High dose irradiation service.	
	^{60}Co Dose: 2 kGy to 55 kGy	2.2 % to 2.9 % depending on the dose	Service reference number: RD05 Dichromate dosimetry service.	
	^{60}Co, ^{137}Cs, photons generated above 2 MeV and electrons generated above 4 MeV. Dose: 20 Gy to 100 kGy	2.6 %	Service reference number: RD06 Alanine dosimetry service	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
RADIOACTIVITY METROLOGY				
RR20 – Standards of Radioactivity (activity per unit mass, Bq g^{-1}): Solutions (or solid substrates spiked directly with such solutions) of α-particle, β-particle, X-ray and γ-ray emitting radionuclides measured by secondary techniques. *Service Reference: RR20*	4 kBq g^{-1} to 15 GBq g^{-1}, depending on radionuclide	0.30 %	Procedures directly supporting this work are: **RMS005** – Standards of Radioactivity Solutions **RMT006** - Measurement of a Gamma Spectrometry Sample **RMT007** - Analysis of a Gamma Spectrometry Sample **RSP014** - Ionisation Chamber Calibration Factors **RMT031** - Activity Assay Using Ionisation Chambers	**Teddington**

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
RADIOACTIVITY METROLOGY (continued)				
RR20 - Standards of Radioactivity (activity per unit mass, Bq g^{-1}): Solutions (or solid substrates spiked directly with such solutions) of α-particle, β-particle and X-ray emitting radionuclides measured by secondary liquid scintillation techniques *Service Reference: RR20*	10 Bq g^{-1} to 500 kBq g^{-1}	0.20 %	Procedures directly supporting this work are: **RMS005** - Standards of Radioactivity Solutions **RMT009** - Secondary Standardisation of Radionuclides using CIEMAT/NIST Technique **RMT010** – Standardisation of Radionuclides by Alpha LSC **RMT012** - Dilution check by liquid scintillation counting Results for gamma emitters may be certificated as gammas s^{-1} g^{-1} by multiplication of the measured activity per unit mass by published emission probabilities.	
RR/0201 – Standard of Radioactivity (activity concentration, Bq m^{-3}): Gaseous radionuclides other than radon *Service Reference: RR02*	0.04 MBq m^{-3} to 30 GBq m^{-3}	1.0 %	Procedures directly supporting this work are: **RMT034** –Standardisation of Gaseous Radionuclides Other Than Radon and Carbon-11	**Teddington**
RR/0203 - Instrument Calibration (response to activity concentration, Bq m^{-3}): Customer supplied radioactivity-in-air monitors (other than radon) *Service Reference: RR02*	40 kBq m^{-3} to 30 GBq m^{-3}	4.0 %	Procedures directly supporting this work are: **RMT03** - Calibration of Tritium-In-Air Monitors	
RR/0301 – Wide Area Reference Source Calibration (surface particle emission rate, particles s^{-1}): Customer supplied radioactive surface contamination sources *Service Reference: RR03*	10 particles s^{-1} to 10000 particles s^{-1}	0.50 % for alpha 1.0 % for beta	Procedures directly supporting this work are: **RMS008** - RR0300 Calibration Service **RMT004** - Measurement of a Wide Area Reference Source by the Primary Large Area Proportional Counter **RQC004** - Quality Checks of the Large Area Proportional Counter **RSP008** - Setting of the Alpha and Beta Counting Thresholds	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
RADIOACTIVITY METROLOGY (continued)				Teddington
RR20- Standards of Radioactivity (activity per unit mass, Bq g^{-1} or γ emission rate per unit mass, s^{-1} g^{-1}): Solutions (or solid substrates spiked directly with such solutions) of Environmental level standards of radioactivity *Service Reference: RR20*	0.001 Bq g^{-1} to 100 kBq g^{-1}, 0.01 s^{-1} g^{-1} to 1000 s^{-1} g^{-1} depending on radionuclide	0.30 %	Procedures directly supporting this work are: **RMS007** - Production of the NPL Mixed Radionuclide Solution **RMS009** - Production of Environmental Radioactivity Standards	
RR/0601 - Standards of Radioactivity (activity concentration, Bq g^{-1}): Solutions of ^{3}H standards for ^{3}H measurement proficiency test *Service Reference: RR06*	10 Bq g^{-1} to 1 kBq g^{-1}	1.0 %	In accordance with HSE Measurement Protocol for Performance Testing of the Determination of Tritium in Water (1993) Procedures directly supporting this work are: **RMS012** - Performance Testing of the Determination of Tritium in Water **RMS013** - Data Analysis of Assigned Value Comparison Exercise Results for Performance Testing of the Determination of Tritium in Water	
RR/0701 - Artefact calibration (activity content, Bq or Activity per unit mass, Bq g^{-1}):): Gelatine capsules (^{131}I *only*), brachytherapy wires (^{192}Ir *only*), brachytherapy seeds (^{125}I *only*) or solutions (or solid substrates spiked directly with such solutions) of α-particle, β-particle, X-ray and γ-ray emitting radionuclides measured by secondary techniques. *Service Reference: RR07*	400 Bq to 15 GBq, 400 Bq $g^{-1}$to 15 GBq g^{-1}, depending on radionuclide	0.30 %	Procedures directly supporting this work are: **RMT031** - Activity Assay using Ionisation Chambers **RSP014 -** Ionisation Chamber Calibration Factors **RMS001 -** Calibration of Customer Supplied Sources (Gamma Emitters) **RMS002** - Calibration of Customer Supplied Sources (Beta Emitters) **RMT006** - Measurement of a Gamma Spectrometry Sample **RMT007** - Analysis of a Gamma Spectrometry Sample **RMT009** - Secondary Standardisation of Radionuclides using CIEMAT/NIST Technique **RMT012** - Dilution check by liquid scintillation counting	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
RADIOACTIVITY METROLOGY (continued)				Teddington
RR/1201 - Calibration of impurity content of radionuclide solutions by high resolution gamma spectrometry (activity per unit mass, Bq g^{-1} or activity concentration, Bq ml^{-1}) *Service Reference: RR12*	0.5 Bq g^{-1} to 100 kBq g^{-1} or 0.5 Bq ml^{-1} to 100 kBq ml^{-1} Energy range 60–1100 keV Energy range 1100-1500 keV	 2.50 % 10 %	Procedures directly supporting this work are: **RMS003** - Customer Impurity checks **RMT006** - Measurement of a Gamma Spectrometry Sample **RMT007** - Analysis of a Gamma Spectrometry Sample	
MASS *Service Reference: MM01* Specific values	Nominal value (g) 50 000 20 000 10 000 5 000 3 000 2 000 1 000 500 300 200 100 50 30 20 10 5 3 2 1 to 0.001 0.0005 to 0.00005	(mg) 2.5 1.0 0.40 0.20 0.20 0.070 0.030 0.015 0.010 0.0070 0.0040 0.0030 0.0030 0.0015 0.0010 0.00060 0.00060 0.00030 0.00020 0.00030	The stated CMCs relate to measurements made on standards that are constructed in accordance with the principles contained in OIML Recommendation III for weights of Class E1. Intermediate values of weights can be calibrated to an uncertainty equal to the greater of the uncertainties associated with the next higher and lower nominal values in the table.	
DENSITY *Service Reference: MM03* Density of solid materials	Artefacts 1100-9000 kg/m3 1 g – 100 g >100 g – 1 kg >1 kg – 20 kg Artefacts >9000 kg/m3 1 g – 100 g >100 g – 1 kg >1 kg – 20 kg	 4.0 – 0.5 kg/m3 0.5 – 0.25 kg/m3 3.0 – 1.0 kg/m3 4.0 – 1.0 kg/m3 1.0 kg/m3 5.0 – 2.0 kg/m3	Using the following apparatus: 100g hydrostatic weighing apparatus 1kg hydrostatic weighing apparatus 20kg hydrostatic weighing apparatus	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
NPL Primary Reference Materials (NPL PRMs) AND NPL CALIBRATED GAS MIXTURES (NPL CGMs) *Service Reference: QE11, QE12 and QE13* NPL Primary Reference Materials (NPL PRMs) Preparation of synthetic gas mixtures by gravimetry in accordance with ISO 6142:2015; verification by analysis. NPL CALIBRATED GAS MIXTURES (NPL CGMs) Certification of synthetic gas mixtures by analysis. The laboratory also has ISO Guide 34 accreditation for production of NPL Primary Reference Materials (NPL PRMs). Accredited certified reference material producer number 4002 http://www.ukas.com/wp-content/uploads/schedule_uploads/00014/4002%20RMP%20Single.pdf Gas mixtures can be produced and/or calibrated as listed below or in the BIPM CMC tables: http://kcdb.bipm.org/appendixc/QM/GB/QM_GB_4.pdf Gas mixtures may be produced and/or calibrated for other amount fractions and/or other combinations of the listed gases.				Teddington
SYNTHETIC NATURAL GAS MIXTURES	Amount fraction %mol/mol	Amount fraction %mol/mol		
Nitrogen	0.02 to 25.2	0.18 % relative + 0.00038	NPL PRMs and NPL CGMs	
Carbon dioxide	0.04 to 25.0	0.20 % relative + 0.00045		
Methane	55.0 to 99.9	0.018 % relative + 0.0020		
Ethane	0.008 to 18	0.28 % relative + 0.000080		
Propane	0.008 to 8.0	0.30 % relative + 0.000080		
i-Butane	0.004 to 1.7	0.40 % relative + 0.000040		
n-Butane	0.004 to 1.7	0.40 % relative + 0.000040		
neo-Pentane	0.0005 to 0.5	0.80 % relative + 0.000015		
i-Pentane	0.0025 to 0.6	0.40 % relative + 0.000030		
n-Pentane	0.0025 to 0.6	0.40 % relative + 0.000030		
n-Hexane	0.0008 to 0.5	0.40 % relative + 0.000018		
Helium	0.001 to 0.5	0.95 % relative + 0.000050		
Oxygen	0.05 to 1.0	1.0% relative		
	Amount fraction μmol/mol	Amount fraction μmol/mol		
Benzene	5 to 500	1.1 % relative + 0.030		
Toluene	5 to 250	1.1 % relative + 0.030		
Cyclohexane	10 to 400	1.1 % relative + 0.030		
Methylcyclohexane	10 to 400	1.1 % relative + 0.030		
n-Heptane	10 to 500	1.1 % relative + 0.040		
n-Octane	5 to 10	1.3 % relative + 0.025		
	10 to 200	1.1 % relative + 0.040		
n-Nonane	1 to 10	1.6 % relative + 0.0090		
	10 to 120	1.2 % relative + 0.048		
n-Decane	1 to 20	1.6 % relative + 0.013		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
NPL PRIMARY REFERENCE MATERIALS (NPL PRMs) AND NPL CALIBRATED GAS MIXTURES (NPL CGMs) (continued)				
SYNTHETIC FUEL GAS MIXTURES	Amount fraction %mol/mol	Amount fraction %mol/mol		
Nitrogen	0.1 to 95	0.30 % relative + 0.0020	NPL PRMs and NPL CGMs	
Carbon monoxide	0.1 to 11	0.48 % relative + 0.0016		
Carbon dioxide	0.3 to 8	0.48 % relative + 0.0016		
Oxygen	0.2 to 2.5	0.78 % relative + 0.0005		
Hydrogen	1 to 70	0.38 % relative + 0.0025		
Helium	1 to 70	0.40 % relative + 0.0025		
Methane	1 to 85	0.33 % relative + 0.0015		
Ethane	0.3 to 35	0.35 % relative + 0.0010		
Ethene	0.1 to 20	0.35 % relative + 0.00030		
Ethyne	0.025 to 2	0.40 % relative + 0.00025		
Propane	0.1 to 18	0.40 % relative + 0.00020		
Propene	0.04 to 10	0.45 % relative + 0.00010		
i-Butane	0.1 to 4	0.40 % relative + 0.00025		
n-Butane	0.1 to 6	0.40 % relative + 0.00025		
1-Butene	0.015 to 1.55	0.45 % relative + 0.00020		
i-Butene	0.018 to 1.2	0.50 % relative + 0.00020		
t-2-Butene	0.015 to 0.85	0.45 % relative + 0.00013		
c-2-Butene	0.015 to 0.35	0.45 % relative + 0.00013		
1,3-Butadiene	0.01 to 3	0.55 % relative + 0.00015		
i-Pentane	0.05 to 0.8	0.45 % relative + 0.00020		
n-Pentane	0.05 to 0.8	0.45 % relative + 0.00020		
SULPHUR ODORANT GAS MIXTURES	Amount fraction μmol/mol	Amount fraction μmol/mol		
Hydrogen sulphide	0.4 to 5,000	NPL PRM	Matrix gas: Methane or nitrogen	
Carbonyl sulphide	0.4 to 5,000	1.0 % relative + 0.0050		
Carbon disulphide	0.4 to 200	(All components)		
Dimethyl sulphide	0.4 to 200			
Ethyl methyl sulphide	0.4 to 200			
Diethyl sulphide	0.4 to 200	NPL CGM		
Methyl mercaptan [Methanethiol]	0.4 to 200	1.2 % relative + 0.0050 (All components)		
Ethyl mercaptan [Ethanethiol]	0.4 to 200			
i-propyl mercaptan [2-propanethiol]	0.4 to 200			
n-propyl mercaptan [1-propanethiol]	0.4 to 200			
Tert-butyl mercaptan [2-methyl-2-propanethiol]	0.4 to 200			
Tetrahydrothiophene [THT]	0.4 to 200			

Teddington

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
NPL PRIMARY REFERENCE MATERIALS (NPL PRMs) AND NPL CALIBRATED GAS MIXTURES (NPL CGMs) (continued)				
BINARY GAS MIXTURES *Service Reference: QE85-0000*	Amount fraction		NPL CGM	**Teddington**
Nitric oxide in nitrogen	100 nmol/mol to 10 μmol/mol	3.0 % relative	Calibrated in accordance with NPL procedure QPDQM/B/517	
OZONE PHOTOMETERS *Service Reference: QE85-0000*				
Ozone in synthetic Air	0 nmol/mol to 100 nmol/mol 100 nmol/mol to 1 μmol/mol	3.0 nmol/mol 3.0 % relative		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
ULTRASONICS *Service Reference: AW07*				Teddington
End-of-cable loaded sensitivity of a hydrophone	1 MHz to 8 MHz 9 MHz to 12 MHz 13 MHz to 16 MHz 17 MHz to 20 MHz 21 MHz to 30 MHz 31 MHz to 40 MHz	6.0 % 7.0 % 8.0 % 11 % 12 % 15 %	Free field sensitivity determined through substitution using a secondary hydrophone in a non-linearly distorted sound field	
End-of-cable loaded sensitivity of a hydrophone in fine frequency range	1 MHz to 8 MHz 9 MHz to 12 MHz 13 MHz to 16 MHz 17 MHz to 20 MHz	8.0 % 9.0 % 10 % 11 %	Free field sensitivity determined through substitution using a secondary hydrophone in a quasi-linear tone-burst acoustic field. Lowest frequency resolution is 10 kHz.	
UNDERWATER ACOUSTICS				
Calibration of hydrophones and projectors *Service Reference: AW15*			According to IEC 60565:2006	
End of cable hydrophone receive sensitivity *Service Reference: AW10*	25 Hz to 400 Hz	0.50 dB	By comparison to a microphone using an air-pistonphone	
Free field sensitivity of reference measuring hydrophones/projectors *Service Reference: AW15*	1 kHz to 2 kHz 2 kHz to 500 kHz	0.70 dB 0.50 dB	Using three-transducer spherical wave reciprocity method in a laboratory tank	
Free field sensitivity of reference measuring hydrophones *Service Reference: AW10*	1 kHz to 2 kHz 2 kHz to 1 MHz	0.90 dB 0.70 dB	By comparison with NPL reference hydrophone in a laboratory tank	
Directional response of transducers and hydrophones *Service Reference: AW10*	1 kHz to 1 MHz	0.21 dB	Normalised response versus angle. XY, XZ and YZ responses available. Performed in a laboratory tank	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
UNDERWATER ACOUSTICS (continued)				Wraysbury
Calibration of hydrophones and projectors *Service Reference: AW15*			According to IEC 60565:2006	
Projector sensitivity	250 Hz to 500Hz 500 Hz to 1kHz 1 kHz to 350 kHz From noise limit to 210 dB re 1 μPa/V at 1 m	1.2dB 1.0 dB 0.9 dB	Using calibrated hydrophone method in an open-water test facility	
Hydrophone sensitivity	250 Hz to 500Hz 500 Hz to 1kHz 1 kHz to 350 kHz From -250 dB to -100 dB re. 1 V/μPa	1.2dB 1.0 dB 0.9 dB	Using calibrated projector method in an open-water test facility	
Complex admittance	250 Hz to 350 kHz		For underwater electro acoustic transducers only. Undertaken in open-water test facility.	
conductance susceptance capacitance		2.0 % + 10 μS 2.0 % + 10 μS 2.0 % + 20 μS		
FORCE				Teddington
Proving devices, load cells and other force-measuring devices in compression and tension modes *Service Reference: MF01*	*50 N Machine* 1.5 N to 50 N *500 N Machine* 25 N to 500 N *2.5 kN Machine* 25 N to 2.5 kN *20 kN Machine* 0.5 kN to 20 kN *120 kN Machine* 2.5 kN to 120 kN *1.2 MN Machine* 10 kN to 1.2 MN *5 MN Machine* 100 kN to 200 kN 200 kN to 5 MN	0.0020 % 0.0020 % 0.0010 % 0.0010 % 0.0010 % 0.0010 % 0.1 % 0.050 %	Calibrations can be performed in accordance with , ASTM E74-18, ISO 376:2011 and BS 8422:2003 standard and supplementary calibrations A, B, E, L and R. Forces can be applied incrementally and decrementally thus permitting the determination of hysteresis errors.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
FORCE (continued)				Teddington
Strain Cylinders *Service Reference: MF03*	200 kN to 2 MN	See remarks	Strain cylinders compared with a reference strain cylinder in a 3 MN compression machine in accordance with BS EN 12390-4:2000.	
Voltage Ratio				
Calibration of DC voltage ratio meters used with strain gauge force transducers *Service Reference: MF04*	0.01 mV/V to 0.05 mV/V 0.05 mV/V to 1.0 mV/V 1.0 mV/V to 2.5 mV/V 2.5 mV/V to 10 mV/V	0.010 % 0.0050 % 0.0070 % 0.0050 %	Ratio meters are compared to a reference resistance network using a precision digital voltmeter to measure the voltage ratios generated	
PRESSURE *Service Reference: MP03* Gas Pressure (absolute)				
Determination of effective area of deadweight testers	3.5 kPa to 16 kPa 16 kPa to 700 kPa 700 kPa to 7 MPa	0.0023 % 0.0021 % 0.0025 % + 0.25 ppm/MPa		
Calibration of pressure indicating instruments	75 kPa to 110 kPa	5.0 Pa		
Gas Pressure (gauge)				
Determination of effective area of deadweight testers	3.5 kPa to 16 kPa 16 kPa to 700 kPa 700 kPa to 7 MPa 7 MPa to 21 MPa	0.0023 % 0.0021 % 0.0025 % + 0.25 ppm/MPa 0.0028 % + 0.50 ppm/MPa		
Oil Pressure (gauge)				
Determination of effective area of deadweight testers	500 kPa to 200 MPa 200 MPa to 500 MPa	0.0031 % + 0.24 ppm/MPa 0.0038 % + 0.24 ppm/MPa		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
FIBRE OPTICS			Measurements carried out at 23 °C ± 2 °C, unless stated otherwise	Teddington
Mode field diameter *Service Reference: OT06-1020*	3.5 μm to 13 μm	0.60 %	Single-mode fibre from 1250 nm to 1625 nm.	
	0 % to 1 %	0.1 %	Far field scan method Petermann II definition	
Mode field noncircularly *Service Reference: OT06-1020*				
Effective area *Service Reference: OT06-1050*	30 μm^2 to 130 μm^2	2.0 %	Far field scan method. Hankel transform	
Dispersion in single-mode optical fibre *Service Reference: OT06-1010*			Fibre length: 2 km to 50 km	
Dispersion	0 $ps.nm^{-1}$ to 1.3 x 10^{-5} $ps.nm^{-1}$	1.5 % added in quadrature with 0.010 $ps.nm^{-1}.km^{-1}$	Laser based system	
Zero dispersion wavelength	1250 nm to 1650 nm	0.10 nm	Laser based system	
Dispersion slope at zero dispersion wavelength	-100 to +100 $ps.nm^{-1}.km^{-1}$	1.5 %	Laser based systems	
Optical length *Service Reference: OT06-1110*	0.1 km to 15 km measured in the wavelength range 1270 nm to 1650 nm.	(0.040 + 1.7 x 10^{-5} L)	Single-mode optical fibre, pulsed time of flight technique.	
	15 km to 105 km measured at wavelengths of 1310 nm, 1550 nm & 1625 nm	(0.10 + 1.7 x 10^{-5} L)	L is optical length in metres	
Fibre attenuation coefficient uniformity *Service Reference: OT06-1100*	0.17 db/km to 0.43 db/km	0.0060 dB/km	Single-mode optical fibre (length 4 km to 14 km). Measured using an optical time domain reflectometer (OTDR), 1300 nm and 1550 nm wavelength windows	
Spectral attenuation of single mode fibre *Service Reference: OT06-1060*	0.1 dB to 35 dB	0.020 dB	Cut-back technique Wavelength range 1200 nm to 1650 nm Measurements carried out over the temperature range 18 °C to 23 °C.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
FIBRE OPTICS (continued)				Teddington
Spectral attenuation of multimode fibre *Service Reference: OT06-1060*	0.1 dB to 35 dB	0.020 dB	Cut-back technique Wavelength range 800 nm to 900 nm 1250 nm to 1350 nm Measurements carried out over the temperature range 18 °C to 23 °C.	
Cut-off wavelength of optical fibre and cable *Service Reference: OT06-1070*	800 nm to 1600 nm	2.0 nm	Transmitted power technique Measurements carried out over the temperature range 18 °C to 23 °C.	
Fibre optic test equipment *Service Reference: OT06-1010*			Measurements carried out at 20 °C ± 2 °C, unless otherwise stated	
Absolute responsivity of fibre optic power meters with FC/PC connectors	*Power level:* *-10 dBm to +23 dBm*		Minimum customer meter resolution 2 % of stated power levels.	
	850 nm ± 30 nm 1300 nm ± 25 nm	0.90 % 0.70 %	Multimode fibre	
	980 nm ± 10 nm 1300 nm ± 25 nm 1500 nm ± 30 nm 1550 nm ± 20 nm 1620 nm ± 20 nm	0.90 % 0.70 % 0.80 % 0.70 % 0.70 %	Single mode fibre	
Absolute responsivity of fibre optic power meters with SC/PC connectors	*Power level:* *-10 dBm to +23 dBm*		Minimum customer meter resolution 2 % of stated power levels	
	850 nm ± 30 nm 980 nm ± 10 nm 1300 nm ± 25 nm	1.5 % 1.5 % 1.0 %	Multimode fibre Single mode fibre Single mode and multi mode fibre	
	Power level: *-10 dBm to +23 dBm*		Minimum customer meter resolution 2 % of stated power levels	
	1500 nm ± 30 nm 1550 nm ± 20 nm 1620 nm ± 20 nm	1.0 % 1.0 % 1.0 %	Single mode fibre	
Absolute responsivity of fibre optic power meters with FC/APC or SC/APC connectors	*Power level:* *- 10 dBm to + 23 dBm*		Minimum customer meter resolution 2 % of stated power levels	
	1500 nm ± 30 nm 1550 nm ± 20 nm 1620 nm ± 20 nm	1.6 % 1.6 % 1.6 %	Single mode fibre	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
Fibre optic test equipment (continued)				Teddington
Linearity in fibre optic power meters with FC/PC, SC/PC, FC/APC and SC/APC connectors - Comparison technique	20 dBm to 10 dBm +10 dBm to -90 dBm	0.70 % 0.30 %	Wavelength range: 830 nm to 1620 nm Single mode and multi mode fibre	
Linearity in fibre optic power meters with FC/PC, SC/PC, FC/APC and SC/APC connectors - Superposition technique	+15 dBm to -90 dBm	0.050 %	Wavelength range: 1275 nm to 1640 nm Single mode fibre	
Effective centre wavelength of fibre optic light source with spectral line width <5 nm	800 nm to 1700 nm	0.30 nm	FC/PC connectorised fibre output	
Effective centre wavelength of fibre optic light source with spectral line width in the range 5 nm to 50 nm	800 nm to 1700 nm	1.2 nm	FC/PC connectorised fibre output	
Spectral line width (FWHM) of sources	0.07 nm to 50 nm	0.10 nm	800 nm to 1700 nm	
Output power stability of fibre optic light sources	+10 dBm to -50 dBm	0.0040 dB	Wavelength range 800 nm to 1700 nm	
PARTICLE COUNTERS *Service Reference: QE15-1010*				
Airborne particle number concentration				
Calibration factor for condensation particle counters	Concentration range 1000 cm^{-3} to 100,000 cm^{-3}	7.0 %	Comparison with an aerosol electrometer	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
INSTRUMENTS FOR AIR QUALITY MONITORING *Service Reference: QE85-0000*				**customers 'sites**
Analyser Calibration	NOx 200 ppb to 2 ppm SO_2 150 ppb to 1 ppm O_3 30 ppb to 1 ppm CO 0.5 ppm to 45 ppm	4.0 %	Two point (zero and span) calibration. An assessment of uncertainty due to analyser repeatability and linearity is also undertaken.	
Determination of onsite standard concentration	NOx 200 ppb to 2 ppm (NO and NO_2) SO_2 150 ppb to 1 ppm CO 0.5 ppm to 45 ppm	4.0 %		
NO_2 molybdenum converter efficiency test	100 ppb to 250 ppb NO_2	1.5 %	Reaction of NO with O_3	
Sample system collection efficiency	NO_2 50 ppb to 150 ppb SO_2 50 ppb to 150 ppb O_3 50 ppb to 150 ppb CO 6 ppm to 12 ppm	1.5 % absolute 1.0 % absolute 1.5 % absolute 1.0 % absolute		
Analyser span noise test	Range as analyser calibration	2.0 ppb		
Analyser zero noise test	NOx, NO, SO_2, O_3, CO	1.0 ppb		
Particulate analyser calibration	0 $mg.m^{-3}$ to 1 $mg.m^{-3}$	1.5 %	Using 4 pre-weighed masses	
Particulate analyser flow rate test	1 slm to 10 slm 10 slm to 40 slm	1.5 % 2.0 %	Volumetric and mass flow	
BINARY GAS MIXTURES *Service Reference: QE85-0000*				
Nitric oxide in nitrogen	200 nmol/mol to 2 μmol/mol	3.0 % relative		
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, and an indication of how they are to be interpreted, are shown below.

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

Over the range 100 mV to 1 V, the CMC is $0.0025\ \% \cdot V + 5.0\ \mu V$, 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.