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EffecTech Limited

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Dove House **Dove Fields** **Uttoxeter** **Staffordshire** **ST14 8HU**	**Contact: Dr Gavin Squire** **Tel: +44 (0)1889 569229** **E-Mail: gavin.squire@effectech.co.uk** **Website: www.effectech.co.uk**

Calibration performed by the Organisations at the locations specified below

Locations covered by the organisation and their relevant activities

Laboratory locations:

Location details		Activity	Location code
Address Dove House Dove Fields Uttoxeter Staffordshire ST14 8HU	**Local contact** Dr Gavin Squire Tel: +44 (0)1889 569229 email: gavin.squire@effectech.co.uk	Gas Calibration Process Gas Analysers Liquefied Natural Gas (LNG) Analysers	Uttoxeter
Address N-163 MIDC Tarapur Boisar District Palghar - 401506 Maharashtra India	**Local contact** Padmakar Tillu Tel: +91 (0)2525 276137 Fax: +91 (0)2525 276827 email: padmakar.tillu@effectech.co.in	Gas Calibration	Tarapur
Address QP West Support Services Area Ghuwairiya Street IR # 1 Ras Laffan Qatar	**Local contact** Biju Davis Tel: +974 5589 8625 Fax: +974 4451 5319 email: biju.davis@effectech.com.qa	Gas Calibration	Qatar

Site activities performed away from the locations listed above:

Location details	Activity	Location code
Customers' sites or premises The customers' 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.	Process Gas Analysers	Customers' 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
PRIMARY REFERENCE GAS MIXTURES (PRGM) Preparation of synthetic gas mixtures by high-precision gravimetry in accordance with ISO 6142-1:2015 (Class I mixtures individually verified by analysis)				
SYNTHETIC NATURAL GAS MIXTURES	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM016/UT**	
nitrogen	0.02 to 25	0.12 % relative + 0.00034	Preparation of primary reference gas mixtures (PRGM) by ISO 6142-1:2015 using high precision gravimetry	
carbon dioxide	0.05 to 25	0.10 % relative + 0.00006		
methane	34 to 100	0.055 - 0.05 % relative		
ethane	0.1 to 35	0.12 % relative + 0.00026		
propane	0.05 to 20	0.15 % relative + 0.00002		
iso-butane	0.01 to 2	0.15 % relative + 0.00011		
n-butane	0.01 to 2	0.15 % relative + 0.00011		
neo-pentane	0.001 to 0.5	0.35 % relative + 0.00005		
iso-pentane	0.002 to 0.6	0.25 % relative + 0.00005		
n-pentane	0.002 to 0.6	0.25 % relative + 0.00005		
n-hexane	0.001 to 0.5	0.50 % relative + 0.00005		
2-methylpentane	0.001 to 0.35	0.65 % relative + 0.00003		
3-methylpentane	0.001 to 0.35	0.65 % relative + 0.00003		
2,2-dimethylbutane	0.001 to 0.35	0.65 % relative + 0.00003		
benzene	0.001 to 0.2	0.65 % relative + 0.00003		
cyclohexane	0.001 to 0.2	0.65 % relative + 0.00003		
n-heptane	0.001 to 0.2	0.65 % relative + 0.00003		
toluene	0.001 to 0.1	0.65 % relative + 0.00003		
methylcyclohexane	0.001 to 0.1	0.65 % relative + 0.00003		
n-octane	0.0005 to 0.05	0.65 % relative + 0.00003		
n-nonane	0.0001 to 0.02	0.65 % relative + 0.00003		
n-decane	0.0001 to 0.005	0.65 % relative + 0.00003		
helium	0.005 to 0.2	0.85 % relative + 0.00022		
hydrogen	0.005 to 0.2	0.80 % relative + 0.0002		**Uttoxetrer**

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
PRIMARY REFERENCE GAS MIXTURES (PRGM) (continued)				Uttoxeter
SYNTHETIC FUEL GAS MIXTURES	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM016/UT**	
nitrogen	0.1 to 60	0.12 % relative + 0.00033	Preparation of primary reference gas mixtures (PRGM) by ISO 6142-1:2015 using high precision gravimetry	
carbon dioxide	0.1 to 30	0.35 % relative		
hydrogen	1 to 40 40 to 70	0.15 % relative + 0.015 0.075		
carbon monoxide	0.1 to 30	0.13 % relative + 0.0038		
methane	1 to 70	0.04		
ethane	0.5 to 28	0.13 % relative + 0.005		
ethene	0.5 to 12	0.6 % relative + 0.0025		
propane	0.1 to 1 1 to 15	0.01 0.2 % relative + 0.0065		
propene	0.1 to 5	0.25 % relative + 0.001		
SULPHUR GAS MIXTURES	amount fraction (ppm mol/mol)	amount fraction (ppm mol/mol)	**In-house method TM016/UT** matrix gas : methane or nitrogen	
hydrogen sulphide	0.2 to 2 2 to 200	0.03 1 % relative + 0.01	Preparation of primary reference gas mixtures (PRGM) by ISO 6142-1:2015 using high precision gravimetry	
carbonyl sulphide	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		
methanethiol (methyl mercaptan)	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		
ethanethiol (ethyl mercaptan)	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		
dimethyl sulphide	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		
2-propanethiol (iso-propyl mercaptan)	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		
ethyl methyl sulphide (methyl ethyl sulphide)	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		
2-methyl-2-propanethiol (tert-butyl mercaptan)	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
PRIMARY REFERENCE GAS MIXTURES (PRGM) (continued)				Uttoxeter
SULPHUR GAS MIXTURES (continued)	amount fraction (ppm mol/mol)	amount fraction (ppm mol/mol)	**In-house method TM016/UT** matrix gas : methane or nitrogen (continued)	
diethyl sulphide	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		
tetrahydrothiophene (THT)	0.2 to 2 2 to 200	0.03 1 % relative + 0.01		
BINARY GAS MIXTURES	amount fraction (mol/mol)	amount fraction (mol/mol)	**In-house method TM016/UT**	
carbon monoxide/nitrogen	10 ppm to 100 ppm 100 ppm to 1000 ppm	0.13 % relative + 0.3 ppm 0.40 % relative	Preparation of primary reference gas mixtures (PRGM) by ISO 6142-1:2015 using high precision gravimetry	
carbon dioxide/nitrogen	0.1 % to 5 % 5 % to 15 %	0.25 % relative + 7.5 ppm 0.10 % relative + 85 ppm		
oxygen/nitrogen	10 ppm to 100 ppm 100 ppm to 1000 ppm 0.1 % to 1.0 % 1.0 % to 22.5 %	0.80 % relative + 0.1 ppm 0.45 % relative + 0.25 ppm 0.35 % relative + 0.5 ppm 0.10 % relative + 15 ppm		
nitric oxide/nitrogen	10 ppm to 60 ppm 60 ppm to 600 ppm	0.10 % relative + 0.13 ppm 0.20 % relative + 0.07 ppm		
nitrogen dioxide/synthetic air	5 ppm to 500 ppm	2.0 % relative		
sulphur dioxide/nitrogen	10 ppm to 200 ppm 200 ppm to 1000 ppm	0.10 % relative + 0.5 ppm 0.30 % relative + 0.1 ppm		
methane/nitrogen	0.1 % to 2 % 2 % to 5 %	0.18 % relative + 5 ppm 0.10 % relative + 25 ppm		
methane/synthetic air	0.1% to 2 % 2 % to 2.5 %	0.18 % relative + 5 ppm 0.10 % relative + 25 ppm		
propane/nitrogen	1 ppm to 1000 ppm 0.1 % to 2 %	0.40 % relative + 0.05 ppm 0.14 % relative + 2.6 ppm		
propane/synthetic air	1 ppm to 1000 ppm 0.1 % to 1.1 %	0.40 % relative + 0.05 ppm 0.14 % relative + 2.6 ppm		
PROPANE BALANCE GAS MIXTURES	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM016/UT**	
nitrogen	0.1 to 3	0.2 % relative + 0.006	Preparation of primary reference gas mixtures (PRGM) by ISO 6142-1:2015 using high precision gravimetry	
ethane	0.25 to 3	0.4 % relative + 0.001		
propane	92 to 99.5	0.21 - 0.20 % relative		
iso-butane	0.03 to 1	0.4 % relative + 0.0005		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
PRIMARY REFERENCE GAS MIXTURES (PRGM) (continued)				Uttoxeter
PROPANE BALANCE GAS MIXTURES (continued)	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM016/UT** (continued)	
n-butane	0.03 to 1	0.4 % relative +0.0005		
iso-pentane	0.02 to 0.08	0.9 % relative		
n-pentane	0.02 to 0.08	0.9 % relative		
CALIBRATED GAS MIXTURES (CGM) Calibration of synthetic gas mixtures by analysis				
SYNTHETIC NATURAL GAS MIXTURES	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM001/UT**	
nitrogen	0.1 to 22	0.25 % relative + 0.0005	Calibration of gas mixtures by ISO 6143:2001 using gas chromatography with thermal conductivity detection (GC-TCD)	
carbon dioxide	0.05 to 15	0.18 % relative + 0.0001		
methane	34 to 100	0.11 - 0.10 % relative		
ethane	0.1 to 35	0.25 % relative		
propane	0.05 to 0.12 0.12 to 15	0.00035 0.3 % relative		
iso-butane	0.01 to 0.15 0.15 to 2	0.00045 0.3 % relative		
n-butane	0.01 to 0.15 0.15 to 2	0.00045 0.3 % relative		
neo-pentane	0.002 to 0.35	0.7 % relative + 0.0001		
iso-pentane	0.005 to 0.35	0.5 % relative + 0.0001		
n-pentane	0.005 to 0.35	0.5 % relative + 0.0001		
n-hexane	0.001 to 0.35	1.0 % relative + 0.0001	Calibration of gas mixtures using gas chromatography with flame ionisation detection (GC-FID)	
2-methylpentane	0.001 to 0.35	1.3 % relative + 0.00005		
3-methylpentane	0.001 to 0.35	1.3 % relative + 0.00005		
2,2-dimethylbutane	0.001 to 0.35	1.3 % relative + 0.00005		
benzene	0.001 to 0.2	1.3 % relative + 0.00005		
cyclohexane	0.001 to 0.2	1.3 % relative + 0.00005		
n-heptane	0.001 to 0.2	1.3 % relative + 0.00005		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
CALIBRATED GAS MIXTURES (CGM) (continued)				Uttoxeter
SYNTHETIC NATURAL GAS MIXTURES (continued)	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM001/UT** (continued)	
toluene	0.001 to 0.1	1.3 % relative + 0.00005		
methylcyclohexane	0.001 to 0.1	1.3 % relative + 0.00005		
n-octane	0.0005 to 0.05	1.3 % relative + 0.00005		
n-nonane	0.0005 to 0.02	1.3 % relative + 0.00005		
n-decane	0.0005 to 0.005	1.3 % relative + 0.00005		
C_6+	0.001 to 0.35	1.0 % relative + 0.0001	C_6+ is the sum of all hydrocarbons containing six carbon atoms or greater	
helium	0.005 to 0.2	1.7 % relative + 0.0004	Calibration of gas mixtures using gas chromatography with thermal conductivity detection (GC-TCD)	
hydrogen	0.005 to 0.2	1.7 % relative + 0.0002		
	amount fraction (mol/mol)	amount fraction (mol/mol)	**In-house method TM026/UT**	
oxygen	10 ppm to 100 ppm 100 ppm to 1000 ppm 0.1 % to 1.0 % 1.0 % to 22.5 % [1]	1.6 % relative + 0.1 ppm 0.9 % relative + 0.5 ppm 0.7 % relative + 1.0 ppm 0.18 % relative + 30 ppm	Calibration of oxygen in gas mixtures by ISO 12963:2017 using galvanic fuel cell sensors Note [1] - The upper limit for oxygen may be limited due to restrictions in place required for the safe manufacture of such mixtures.	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
CALIBRATED GAS MIXTURES (CGM) (continued)				Tarapur
SYNTHETIC NATURAL GAS MIXTURES (continued)	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM005/TA**	
nitrogen	0.1 to 12	0.3 % relative + 0.0005	Calibration of gas mixtures by ISO 6143:2001 using gas chromatography with thermal conductivity detection (GC-TCD)	
carbon dioxide	0.05 to 8	0.22 % relative + 0.0003		
methane	64 to 100	0.11 - 0.10 % relative		
ethane	0.1 to 14	0.25 % relative		
propane	0.05 to 8	0.5 % relative + 0.0005		
iso-butane	0.01 to 0.15 0.15 to 1.2	0.0006 0.4 % relative		
n-butane	0.01 to 0.15 0.15 to 1.2	0.0006 0.4 % relative		
neo-pentane	0.002 to 0.35	1.0 % relative + 0.0002		
iso-pentane	0.005 to 0.35	0.6 % relative + 0.0002		
n-pentane	0.005 to 0.35	0.6 % relative + 0.0002		
n-hexane	0.001 to 0.35	1.6 % relative + 0.00005	Calibration of gas mixtures using gas chromatography with flame ionisation detection (GC-FID)	
2-methylpentane	0.001 to 0.35	1.6 % relative + 0.00005		
3-methylpentane	0.001 to 0.35	1.6 % relative + 0.00005		
2,2-dimethylbutane	0.001 to 0.35	1.6 % relative + 0.00005		
benzene	0.001 to 0.2	1.6 % relative + 0.00005		
cyclohexane	0.001 to 0.2	1.6 % relative + 0.00005		
n-heptane	0.001 to 0.2	1.6 % relative + 0.00005		
toluene	0.001 to 0.1	1.6 % relative + 0.00005		
methylcyclohexane	0.001 to 0.1	1.6 % relative + 0.00005		
n-octane	0.0005 to 0.05	1.6 % relative + 0.00005		
n-nonane	0.0005 to 0.02	1.6 % relative + 0.00005		
n-decane	0.0005 to 0.005	1.6 % relative + 0.00005		
oxygen	0.005 to 1	5 % relative	Calibration of gas mixtures using gas chromatography with thermal conductivity detection (GC-TCD)	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
CALIBRATED GAS MIXTURES (CGM) (continued)				Qatar
SYNTHETIC NATURAL GAS MIXTURES (continued)	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM022/QA**	
nitrogen	0.1 to 12	0.35 % relative + 0.0005	Calibration of gas mixtures by ISO 6143:2001 using gas chromatography with thermal conductivity detection (GC-TCD)	
carbon dioxide	0.05 to 8	0.20 % relative + 0.0005		
methane	64 to 100	0.13 – 0.11 % relative		
ethane	0.1 to 14	0.30 % relative +0.002		
propane	0.05 to 8	0.30 % relative		
iso-butane	0.01 to 0.15 0.15 to 1.2	0.0005 0.35 % relative		
n-butane	0.01 to 0.15 0.15 to 1.2	0.0005 0.35 % relative		
neo-pentane	0.004 to 0.35	3.5 % relative + 0.0005		
iso-pentane	0.005 to 0.1 0.1 to 0.35	0.001 0.9 % relative - 0.0006		
n-pentane	0.005 to 0.18 0.18 to 0.35	0.001 0.9 % relative - 0.0006		
n-hexane	0.001 to 0.35	1.7 % relative + 0.00005	Calibration of gas mixtures using gas chromatography with flame ionisation detection (GC-FID)	
2-methylpentane	0.001 to 0.35	1.7 % relative + 0.00005		
3-methylpentane	0.001 to 0.35	1.7 % relative + 0.00005		
2,2-dimethylbutane	0.001 to 0.35	1.7 % relative + 0.00005		
benzene	0.001 to 0.2	1.7 % relative + 0.00005		
cyclohexane	0.001 to 0.2	1.7 % relative + 0.00005		
n-heptane	0.001 to 0.2	1.7 % relative + 0.00005		
toluene	0.001 to 0.1	1.7 % relative + 0.00005		
methylcyclohexane	0.001 to 0.1	1.7 % relative + 0.00005		
n-octane	0.0005 to 0.05	1.7 % relative + 0.00005		
n-nonane	0.0005 to 0.02	1.7 % relative + 0.00005		
n-decane	0.0005 to 0.005	1.7 % relative + 0.00005		
oxygen	0.005 to 1	5 % relative	Calibration of gas mixtures using gas chromatography with thermal conductivity detection (GC-TCD)	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
GAS MIXTURE PROPERTIES Calculated values from composition				
superior calorific value molar basis (kJ.mol^{-1}) mass basis (MJ.kg^{-1}) volume basis (MJ.m^{-3})	Calculations are restricted to gas mixtures with amount fraction (% mol/mol)	 0.1 % relative 0.1 % relative 0.1 % relative	Values calculated according to **ISO 6976:1995** (including amendment No 1, May 1998) on a *real* or *ideal* gas basis assuming mixture is dry (free from water)	**All Sites**
inferior calorific value molar basis (kJ.mol^{-1}) mass basis (MJ.kg^{-1}) volume basis (MJ.m^{-3})	nitrogen < 30 carbon dioxide < 15 ethane < 15 other components < 5 methane no restriction	 0.1 % relative 0.1 % relative 0.1 % relative	Combustion properties can be expressed in units of the Joule (J) or in kilowatt hours (kWh)	
relative density density (kg.m^{-3})		0.1 % relative 0.1 % relative		
superior Wobbe index (MJ.m^{-3}) inferior Wobbe index (MJ.m^{-3})		0.1 % relative 0.1 % relative		
molar mass (kg.kmol^{-1}) compression factor		0.1 % relative 0.1 % relative		
gross calorific value molar basis (kJ.mol^{-1}) mass basis (MJ.kg^{-1}) volume basis (MJ.m^{-3})	Calculations are applicable to any gaseous natural gas, natural gas substitute, or other combustible fuel, except that for properties on a volume basis, where the method is restricted only to gas mixtures for which the compression factor is greater than 0.9	 1.0 kJ.mol^{-1} 0.025 MJ.kg^{-1} 0.040 MJ.m^{-3}	Values calculated according to **ISO 6976:2016** on a *real* or *ideal* gas basis assuming mixture is dry (free from water)	
net calorific value molar basis (kJ.mol^{-1}) mass basis (MJ.kg^{-1}) volume basis (MJ.m^{-3})		 0.9 kJ.mol^{-1} 0.023 MJ.kg^{-1} 0.037 MJ.m^{-3}	Combustion properties can be expressed in units of the Joule (J) or in kilowatt hours (kWh)	
relative density density (kg.m^{-3})		0.0006 0.0008 kg.m^{-3}		
gross Wobbe index (MJ.m^{-3}) net Wobbe index (MJ.m^{-3})		0.032 MJ.m^{-3} 0.030 MJ.m^{-3}		
molar mass (kg.kmol^{-1}) compression factor		0.017 kg.kmol^{-1} 0.0001		
gross heating value net heating value relative density compressibility factor	There are no composition or property-related restrictions on the method specified	0.1 % relative 0.1 % relative 0.1 % relative 0.1 % relative	Calculated values according to methods given in **GPA 2172-09** (2009) using data tables from **GPA 2145-09**	
gross heating value net heating value relative density density compressibility factor	There are no composition or property-related restrictions on the method specified	0.1 % relative 0.1 % relative 0.1 % relative 0.1 % relative 0.1 % relative	Calculated values according to methods given in **ASTM D3588-98** (2011) using data tables from **GPA 2145-09**	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
CALIBRATED GAS MIXTURES (CGM) (continued)				Uttoxeter
SULPHUR GAS MIXTURES	amount fraction (ppm mol/mol)	amount fraction (ppm mol/mol)	**In-house method TM002/UT** matrix gas : methane or nitrogen	
hydrogen sulphide	0.2 to 10	2 % relative + 0.03	Calibration of gas mixtures using gas chromatography with sulphur chemiluminescence detection (GC-SCD)	
carbonyl sulphide	0.2 to 10	2 % relative + 0.03		
methanethiol (methyl mercaptan)	0.2 to 10	2 % relative + 0.03		
ethanethiol (ethyl mercaptan)	0.2 to 10	2 % relative + 0.03		
dimethyl sulphide	0.2 to 10	2 % relative + 0.03		
1-propanethiol (n-propyl mercaptan)	0.2 to 10	4 % relative + 0.03		
2-propanethiol (iso-propyl mercaptan)	0.2 to 10	2 % relative + 0.03		
ethyl methyl sulphide (methyl ethyl sulphide)	0.2 to 10	2 % relative + 0.03		
1-butanethiol (n-butyl mercaptan)	0.2 to 10	4 % relative + 0.03		
2-methyl-2-propanethiol (tert-butyl mercaptan)	0.2 to 10	2 % relative + 0.03		
2-methyl-1-propanethiol (iso-butyl mercaptan)	0.2 to 10	4 % relative + 0.03		
1-methyl-1-propanethiol (sec-butyl mercaptan)	0.2 to 10	4 % relative + 0.03		
diethyl sulphide	0.2 to 10	2 % relative + 0.03		
n-hexyl mercaptan	0.2 to 10	4 % relative + 0.03		
tetrahydrothiophene (THT)	0.2 to 10	2 % relative + 0.03		
BLAST FURNACE GAS MIXTURES	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM004/UT**	
nitrogen	27 to 54	0.25 % relative	Calibration of gas mixtures by ISO 6143:2001 using gas chromatography with thermal conductivity detection (GC-TCD)	
carbon dioxide	20 to 31	0.25 % relative		
hydrogen	1 to 16	0.25 % relative +0.03		
carbon monoxide	20 to 31	0.25 % relative		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
CALIBRATED GAS MIXTURES (CGM) (continued)				Uttoxeter
BASIC OXYGEN STEELMAKING GAS (BOS)	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM004/UT**	
nitrogen	11 to 30	0.2 % relative + 0.02	Calibration of gas mixtures by ISO 6143:2001 using gas chromatography with thermal conductivity detection (GC-TCD)	
carbon dioxide	12 to 20	0.2 % relative + 0.02		
carbon monoxide	45 to 75	0.15 - 0.1 % relative		
hydrogen	0.4 to 3	0.5 % relative + 0.002		
oxygen	0.3 to 1.3	0.7 % relative + 0.0005		
PROPANE BALANCE GAS MIXTURES	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM020/UT**	
nitrogen	0.1 to 3	0.25 % relative + 0.007	Calibration of gas mixtures using gas chromatography with thermal conductivity detection (GC-TCD)	
ethane	0.25 to 3	0.45 % relative + 0.002		
propane	92 to 99.5	0.21 - 0.2 % relative		
iso-butane	0.03 to 1	0.45 % relative + 0.0005		
n-butane	0.03 to 1	0.45 % relative + 0.0005		
iso-pentane	0.02 to 0.08	1.2 % relative + 0.0001		
n-pentane	0.02 to 0.08	1.2 % relative + 0.0001		
BINARY EMISSION GAS MIXTURES	amount fraction (µmol/mol)	amount fraction (µmol/mol)	**In-house method TM025/UT**	
propane in nitrogen	3 to 100	0.6 % relative + 0.1	Calibration of gas mixtures by ISO 12963:2017 using gas chromatography with flame ionisation detection (GC-FID)	
propane in synthetic air	3 to 100	0.6 % relative + 0.1		
BINARY GAS MIXTURES	amount fraction (mol/mol)	amount fraction (mol/mol)	**In-house method TM026/UT**	
oxygen in nitrogen	10 ppm to 100 ppm 100 ppm to 1000 ppm 0.1 % to 1.0 % 1.0 % to 22.5 %	1.6 % relative + 0.1 ppm 0.9 % relative + 0.5 ppm 0.7 % relative + 1.0 ppm 0.18 % relative + 30 ppm	Calibration of gas mixtures by ISO 12963:2017 using galvanic fuel cell sensors	
TERTIARY EMISSION GAS MIXTURES	amount fraction (mol/mol)	amount fraction (mol/mol)	**In-house method TM014**	
nitric oxide nitrogen dioxide in nitrogen	10 ppm to 60 ppm 60 ppm to 600 ppm 5 ppm to 500 ppm	0.20 % relative + 0.25 ppm 0.40 % relative + 0.13 ppm 4.0 % relative	Calibration of gas mixtures by ISO 12963:2017 using dynamically generated reference gases in accordance with ISO 6145 Part 7 Thermal Mass Flow Controllers	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
CALIBRATED GAS MIXTURES (CGM) (continued)				Uttoxeter and Tarapur
BINARY EMISSION GAS MIXTURES	amount fraction (mol/mol)	amount fraction (mol/mol)	**In-house method TM014**	
carbon monoxide in nitrogen or synthetic air	10 ppm to 100 ppm 100 ppm to 1000 ppm	0.25 % relative + 0.55 ppm 0.80 % relative	Calibration of gas mixtures by ISO 12963:2017 using dynamically generated reference gases in accordance with ISO 6145 Part 7 Thermal Mass Flow Controllers	
nitric oxide in nitrogen	10 ppm to 60 ppm 60 ppm to 600 ppm	0.20 % relative + 0.25 ppm 0.40 % relative + 0.13 ppm		
nitrogen dioxide in synthetic air	5 ppm to 500 ppm	4.0 % relative		
sulphur dioxide in nitrogen or synthetic air	10 ppm to 200 ppm 200 ppm to 1000 ppm	0.17 % relative + 1.0 ppm 0.60 % relative + 0.12 ppm		
carbon dioxide in nitrogen or synthetic air	0.1 % to 5 % 5 % to 15 %	0.50 % relative + 15 ppm 0.20 % relative + 170 ppm		
oxygen in nitrogen	0.5 % to 3 % 3 % to 25 %	0.50 % relative + 85 ppm 0.40 % relative + 100 ppm		
methane in nitrogen	0.1 % to 2 % 2 % to 5 %	0.35 % relative + 10 ppm 0.15 % relative + 50 ppm		
methane in synthetic air	0.1 % to 2 % 2 % to 2.5 %	0.35 % relative + 10 ppm 0.15 % relative + 50 ppm		
LIQUEFIED NATURAL GAS (LNG) ANALYSERS Calibration of LNG analysers using reference liquid mixtures				Uttoxeter
LNG ANALYSERS	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM024/UT**	
nitrogen	0.1 to 1.8	0.10 % relative + 0.0065	Calibration of analysers used for direct measurement of liquefied natural gas (LNG) using cryogenically prepared reference liquid mixures	
methane	79 to 100	0.035		
ethane	0.1 to 4 4 to 14	0.30 % relative + 0.001 0.05 % relative + 0.01		
propane	0.1 to 4	0.15 % relative + 0.0015		
iso-butane	0.02 to 1.3	0.25 % relative + 0.001		
n-butane	0.02 to 1.3	0.25 % relative + 0.001		
iso-pentane	0.01 to 0.16	0.50 % relative + 0.0002		
n-pentane	0.01 to 0.16	0.50 % relative + 0.0002		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
GAS ANALYSERS Calibration of gas analysers using reference gas mixtures				
NATURAL GAS ANALYSERS	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM003**	
nitrogen	0.1 to 22	0.25 % relative + 0.0005	Calibration of gas analysers used for natural gas analysis in accordance with ISO 10723:2012	
carbon dioxide	0.05 to 15	0.18 % relative + 0.0001		
methane	34 to 100	0.07		
ethane	0.1 to 23	0.25 % relative		
propane	0.05 to 10	0.3 % relative		
iso-butane	0.01 to 0.15 0.15 to 2	0.00045 0.3 % relative		
n-butane	0.01 to 0.15 0.15 to 2	0.00045 0.3 % relative		
neo-pentane	0.005 to 0.35	0.7 % relative + 0.0001		
iso-pentane	0.005 to 0.35	0.5 % relative + 0.0001		
n-pentane	0.005 to 0.35	0.5 % relative + 0.0001		
n-hexane	0.001 to 0.35	1.0 % relative + 0.0001		
n-heptane	0.001 to 0.20	1.3 % relative + 0.00005		
n-octane	0.0005 to 0.05	1.3 % relative + 0.00005		
n-nonane	0.0005 to 0.02	1.3 % relative + 0.00005		
n-decane	0.0005 to 0.005	1.3 % relative + 0.00005		
OTHER FUEL GAS ANALYSERS	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM006**	
C_1 - C_3	0.0008 to 100	amount fractions from 1 % to 100 % ± 0.5 % relative	Calibration of gas analysers based on ISO 10723:2012	
C_4	0.001 to 50			
C_5	0.001 to 9	amount fractions from 0.1 % to 1 % ± 1 % relative		
C_6	0.001 to 1.5			
C_7	0.001 to 0.5	amount fractions from 0.0008 % to 0.1 % ± 2 % relative		
C_8	0.001 to 0.2			
C_9	0.001 to 0.2			
C_{10}	0.001 to 0.05			

Customers' sites

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
GAS ANALYSERS (continued)				**Customers' sites**
OTHER FUEL GAS ANALYSERS (continued)	amount fraction (% mol/mol)	amount fraction (% mol/mol)	**In-house method TM006** (continued)	
benzene	0.001 to 1	amount fractions from 1 % to 100 % ± 0.5 % relative		
toluene	0.001 to 0.4			
xylenes (m, p and o)	0.001 to 0.1	amount fractions from 0.1 % to 1 % ± 1 % relative		
argon	0.1 to 100			
carbon dioxide	0.03 to 100	amount fractions from 0.0008 % to 0.1 % ± 2 % relative		
carbon monoxide	0.001 to 100			
helium	0.1 to 100			
hydrogen	0.08 to 100			
nitrogen	0.1 to 100			
oxygen	0.05 to 100			
OTHER GAS ANALYSERS	amount fraction (ppm mol/mol)	amount fraction (ppm mol/mol)		
hydrogen sulphide	1 to 10	2 % relative + 0.03		

END

Appendix - Calibration and Measurement Capabilities

Introduction

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

Calibration and Measurement Capabilities (CMCs)

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

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

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

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

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

Expression of CMCs - symbols and units

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

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

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

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