

# Maximum precision for quantifiable success.

Reference materials and other accredited calibration gas mixtures.



# It's now official: Linde sets standards.

Linde has a lot of accredited laboratories according to ISO 17025 in many countries. This was followed in 2009 by accreditation as a producer of reference materials to ISO Guide 34 in Europe and Asia, and in 2013 in the USA.

Linde is now literally setting standards for the calibration of gas measuring instruments and is the first gas supplier in the German-speaking world able to produce gas mixtures covering all metrological hierarchies. This means that, as an industrial enterprise, we are making a key contribution to the metrological infrastructure worldwide.



# Linde quality hierarchy for calibration gas mixtures.

In an age of global trade, analytical measuring results have to be comparable. This requirement is meanwhile satisfied by a large number of international directives and standards, e.g. DIN EN ISO/IEC 17025<sup>1</sup>. Such regulations call for the metrological traceability of measuring results using certified reference materials as the basis for comparability. Traceability is the possibility of verifying measuring results through calibration with measuring instruments of a known accuracy which are linked to acknowledged measurement standards. In the world of physical metrology, such standard measures are the internationally recognised

embodiment of the relevant SI units. These principles form the basis for the analytical results of test and calibration laboratories.

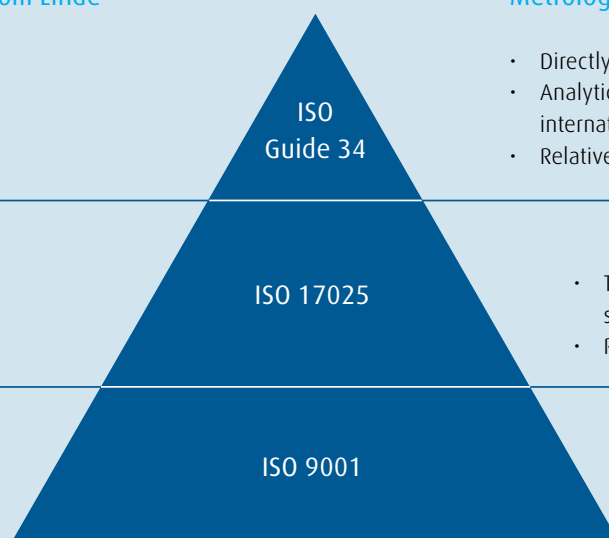
Linde calibration gas mixtures are distinguished according to the degree of accuracy required. The mixtures are produced in coordinated levels of manufacturing tolerance, measurement uncertainty and traceability. Highly optimised production processes and analysis methods allow us to offer mixtures that accurately match customer requirements in terms of precision while satisfying all definitive norms.

## Calibration gas mixtures from Linde

**Reference materials**  
Accreditation as manufacturer of reference materials

**Mixtures with DAkkS calibration certificate**  
Accreditation as a calibration laboratory

**Standard gas mixtures: class 1**  
QM – Linde Gas certification



## Metrological properties

- Directly traceable to SI base unit (kg)
- Analytical verification against internationally accepted standards
- Relative measurement uncertainty  $\approx 0.5\%$

- Traceable to internationally accepted standards (BAM, NMI, NPL, etc.)
- Relative measurement uncertainty  $\approx 1\%$

- Traceable to Internal Linde standards (PEH mixture)
- Relative measurement uncertainty  $\geq 2\%$

<sup>1</sup> DIN EN ISO/IEC 17025 "General requirements for the competence of testing & calibration laboratories"

# Reference materials.

ISO Guide 34<sup>2</sup> defines reference materials as mixtures of substances with an extremely precise composition, which are linked to the International System of Units (SI) by complete metrological traceability and a specified level of measurement uncertainty. Reference materials used for the calibration of measuring instruments form an essential part of analytical chemistry.

Our reference materials have been developed for customers with exacting requirements in terms of measurement uncertainty and traceability. The determination of reference values is based on the international standards ISO 6142 "Gas analysis – Preparation of calibration gas mixtures – Gravimetric method" and ISO 6143 "Gas analysis – Comparison methods for determining and checking the composition of calibration gas mixtures".

Preparation of the mixtures involves determining the amount of each component by means of gravimetric analysis. The high-precision sets of masses used here are periodically calibrated by approved calibration laboratories. Our reference materials are thus directly traceable to the SI base unit of the kilogram. The accuracy achievable with the gravimetric method significantly depends on the purity of the parent gas used to produce the mixtures. For Linde reference materials we therefore only use high purity base gases and compressed gas containers, which have undergone first-class pretreatment.

After filling, the gravimetrically prepared mixtures are homogenised and verified by means of analysis. The calibration gases used for such analysis are themselves traceable to gas mixtures of the national metrology institutes BAM<sup>3</sup>, NPL<sup>4</sup> and VSL (NMI)<sup>5</sup>. Analytical verification is subject to stringent requirements, which are described in detail in ISO 6143 and ISO Guide 35<sup>6</sup>.

The calculation of the measurement uncertainty for the certified values complies with the recommendations of GUM (ISO/IEC Guide 98-3: 2008 "Guide to the Expression of Uncertainty in Measurement"). Linde has developed and validated a software program called "HiQ calc" for this

Reference Material Producer / Hersteller von Referenzmaterialien  
 accredited by / akkreditiert durch  
**Deutsche Akkreditierungsstelle GmbH**

**Certified Reference Material / Zertifiziertes Referenzmaterial** **DAkkS**  
 Standard  
 Akkreditierungszusatz  
 D-PM-14140-01-03

Comment: The laboratory DAkkS 14140-01-03 is accredited on basis of ISO Guide 34:2008 and DIN EN ISO 9001:2008  
 Hinweis: Das Labor DAkkS 14140-01-03 ist akkreditiert nach ISO Guide 34:2008 und DIN EN ISO 9001:2008

CRM Certificate No. / Zertifikatsnummer	Linde-CRM 4153	Type / Typ	LCRM-34
Order number / Bestellnummer	4851268	Order No. / Auftragsnummer	18300248288
Date of preparation / Herstellungsdatum	18.05.2018		
Manufacturer / Hersteller	Linde AG, Spedition Deutschland, Carl-von-Linde Str. 25, D-50574 Köln-Weidenfels, GERMANY, CRM@de.linde-gas.com		
Customer / Auftraggeber	LINDE FRANCE S.A., ACTIVITE INDUSTRIELLE-LINDE GAZ, 18 PARC TECHNOLOGIQUE DE LYON, 8, ALLÉE IRENE JOLYOT-CURIE, F - 69682 SAINT PRIEST CEDEX		
Procedure / Verfahren / Methodikbeschreibung / Methodikname	Primary Gravimetric Calibration Gas Mixtures / ISO 6142:2008		

**Certified Amount Fractions and Uncertainty / Zertifizierte Werte und Messunsicherheit**

Species / Reinstoffgruppe	Amount Fraction / Stoffmengenanteil	
	Ordered / Bestellt / nominal	Result / Ergebnis / measured
Hydrogen / Wasserstoff	48 ± 18 <sup>4</sup>	48,0 ± 0,4 * 18 <sup>4</sup>
Argon / Argon	Balance / Rest	Balance / Rest

Order number / Bestellnummer: 4851268  
 Filling pressure / Fülldruck: 198 bar  
 Value under / Wert unter: 200 kPa (14,7 psi)  
 Date of expiry / Verfallsdatum: 30.11.2019

Min. storage temperature / Min. Lagertemperatur: 5 °C  
 Min. pressure of utilization / Min. bei Verwendung: 8 bar  
 Handling / Handhabung: Refer to ISO 11089:2004  
 Remarks and / Anmerkungen: Calibration: Germany

The components were certified on the basis of gravimetry in accordance with ISO 6142:2008. The results were verified against primary and/or internationally traceable reference material. The expanded uncertainty assigned to the measurement results is obtained by multiplying the measured uncertainty by the coverage factor k = 2. It has been determined in accordance with Guide to the expression of uncertainty in measurement. The value of the measurement lies within the assigned range of values with a probability of 95%.  
 Die (Zertifikat) Werte wurden auf Basis der Gravimetrie in Übereinstimmung mit ISO 6142:2008 ermittelt. Die Ergebnisse wurden gegen primäre und/oder international nachweisbare Referenzmaterialien verglichen. Die den Messergebnissen zugeordnete erweiterte Messunsicherheit ergibt sich aus der Messunsicherheit durch Multiplikation mit dem Erweiterungsfaktor k = 2. Die Werte gemäß Guide to the expression of uncertainty in measurement. Der Wert des Messergebnisses liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertebereich.

Date / Datum:	18.05.2018	Head of Laboratory / Laborant:	Maria-Joana Schmitt	Person in charge / Verantwortlich:	Delphine Brévière
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18111 cert

Typical certificate for a reference material

purpose and it forms one of the cornerstones of our accreditation as a producer of reference materials.

Linde reference materials offer users major benefits:

- International comparability at the highest level
- Short delivery times
- Simple order processing via Linde delivery service

<sup>2</sup> ISO Guide 34 "General requirements for the competence of reference material producers"

<sup>3</sup> BAM: Federal Institute for Materials Research and Testing (Germany)

<sup>4</sup> NPL: National Physical Laboratory (UK)

<sup>5</sup> VSL (NMI): Dutch Metrology Institute (Netherlands)

<sup>6</sup> ISO Guide 35 "Reference materials – General & statistical principles for certification"

# Calibration gas mixtures with accreditation certificate.

Official stipulations are prompting customers to increasingly make the award of contracts conditional on accreditation as a calibration laboratory. Calibration performed by calibration laboratories offers users certainty as regards the reliability of measuring results, improves competitive ability on national and international markets and serves as a metrological basis for monitoring measuring instruments and test equipment in the framework of quality assurance.

International accreditation bodies have confirmed that our accredited calibration laboratories in many countries, e.g. Germany and United Kingdom, meet the stringent requirements of DIN EN ISO/IEC 17025. Accreditation in Germany is carried out by the Deutsche Akkreditierungsstelle (DAKKS) Accreditation Body and in Switzerland by the Swiss Calibration Service (SCS).

BOC Limited, a member of The Linde Group in the UK, also has accreditation from the United Kingdom Accreditation Service (UKAS) to ISO Guide 34 as a Reference Materials Producer and ISO/IEC 17025 as a Calibration Laboratory for a wide range of calibration gas mixtures. Our accredited calibration mixtures are traceable to internationally recognised reference materials of BAM, NPL and VSL (NMI) and our own reference materials.

Our accreditations include calibration for binary and multicomponent mixtures, as well as calibration gases for emissions testing, calorific value measuring instruments and process gas chromatographs. These mixtures are preferably filled into 10 and 40 litre aluminium cylinders.

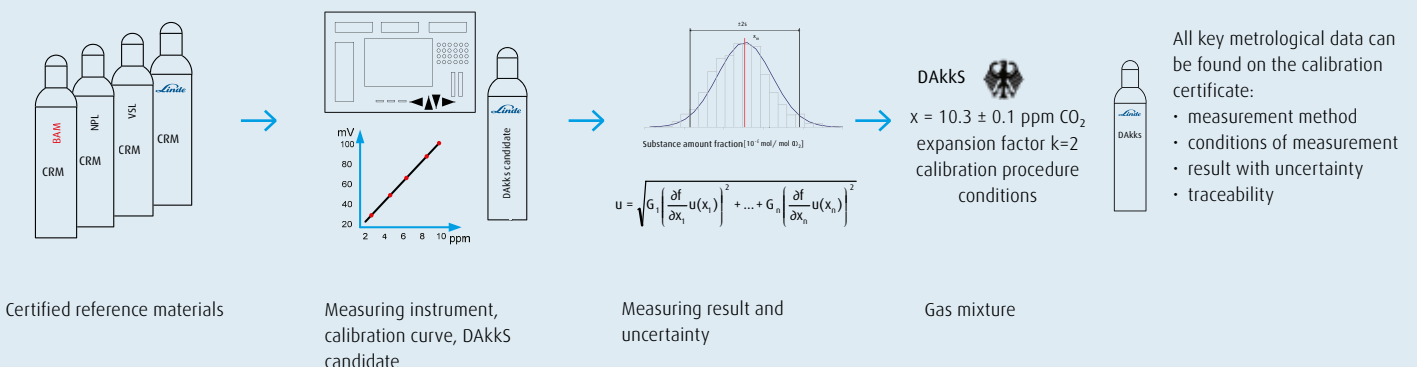


DAKKS calibration certificate

The key customer benefits of accredited calibration are:

- International validity of measured values determined
- High standing of accreditations in many countries both inside and outside Europe
- Evidence of traceability, in particular for accredited testing laboratories

## Procedure for analysis and certification for calibration accredited mixtures



Certified reference materials

Measuring instrument, calibration curve, DAKKS candidate

Measuring result and uncertainty

Gas mixture

# Excerpt from Linde's delivery programme.

## Reference materials (DAKKS, ISO Guide 34)

	Measured variable	Amount fraction	Matrix	Relative uncertainty (%)
Binary mixtures	CO	5 ppm-10 %	N <sub>2</sub> , Synthetic Air*	0.5-0.8
	CO <sub>2</sub>	5 ppm-30 %	N <sub>2</sub> , Synthetic Air	0.5-0.8
	CH <sub>4</sub>	5 ppm-50 %	N <sub>2</sub> , Synthetic Air*	0.5-0.8
	C <sub>2</sub> H <sub>6</sub>	10 ppm-5 %	N <sub>2</sub> , CH <sub>4</sub>	0.5-0.8
	C <sub>3</sub> H <sub>8</sub>	5 ppm-5 %	N <sub>2</sub> , CH <sub>4</sub>	0.5-0.8
	NO	5 ppm-1 %	N <sub>2</sub>	0.5-0.8
	O <sub>2</sub>	5 ppm-25 %	N <sub>2</sub>	0.5-0.8
	SO <sub>2</sub>	5-1000 ppm	N <sub>2</sub> , Synthetic Air*	0.8
	NO <sub>2</sub>	5-1000 ppm	Synthetic Air	1.0
Mixtures for emissions testing	CO, CO <sub>2</sub> , C <sub>3</sub> H <sub>8</sub> , O <sub>2</sub>	Varying	N <sub>2</sub>	0.5-0.8
Synthetic natural gas mixtures	C <sub>2</sub> -C <sub>6</sub> , CO <sub>2</sub> , CO, O <sub>2</sub> , N <sub>2</sub> , H <sub>2</sub> , He	Varying	CH <sub>4</sub>	0.5-1.0
NB	*Only outside flammable limits			

## Calibration laboratory (DAKKS, ISO 17025)

	Measured variable	Amount fraction	Matrix	Relative uncertainty (%)	
Binary and/or ternary mixtures	He **	1%-50%	N <sub>2</sub> , Synthetic Air	1.0	
	CO **	5 ppm-10 %	N <sub>2</sub> , Synthetic Air*	1.0	
	CO <sub>2</sub> **	5 ppm-30 %	N <sub>2</sub> , Synthetic Air	1.0	
	CH <sub>4</sub> **	5 ppm-50 %	N <sub>2</sub> , Synthetic Air*	1.0	
	C <sub>3</sub> H <sub>8</sub> **	5 ppm-5 %	N <sub>2</sub> , CH <sub>4</sub>	1.0	
	NO **	5 ppm-1 %	N <sub>2</sub>	1.0	
	O <sub>2</sub> **	5 ppm-30 %	N <sub>2</sub>	1.0	
	SO <sub>2</sub> **	1-5000 ppm	N <sub>2</sub>	1.0	
	NO <sub>2</sub> **	5-1000 ppm	Synthetic Air	2.0	
	NH <sub>3</sub>	5-500 ppm	N <sub>2</sub>	2.0	
	C <sub>6</sub> H <sub>14</sub>	5-500 ppm	N <sub>2</sub> , Synthetic Air	2.0	
	H <sub>2</sub>	1-20 %	N <sub>2</sub>	1.0	
	Quaternary and pentanary mixtures	CO, CO <sub>2</sub> , C <sub>3</sub> H <sub>8</sub>	Varying	N <sub>2</sub>	1.0
		CO, SO <sub>2</sub> , NO	Varying	N <sub>2</sub>	1.0
CO, CO <sub>2</sub> , C <sub>3</sub> H <sub>8</sub> , O <sub>2</sub>		Varying	N <sub>2</sub>	1.0	
Synthetic mixtures of natural gas	C <sub>2</sub> -C <sub>6</sub> , CO <sub>2</sub> , CO, O <sub>2</sub> , N <sub>2</sub> , H <sub>2</sub> , He	Varying	CH <sub>4</sub>	1.0-2.0	
NB	* Only outside flammable limits				
	** two of these components can be used in ternary mixtures				





# Getting ahead through innovation.

With its innovative concepts, Linde is playing a pioneering role in the global market. As a technology leader, it is our task to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

Linde offers more. We create added value, clearly discernible competitive advantages and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardised as well as customised solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimisation and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, joint activities form the core of commercial success.

Linde – ideas become solutions.

Visit the HiQ smartphone site:



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