

# VAPOR EQUIVALENT CONCENTRATION AND UNCERTAINTY

Provider: ACS  
Lot Number: 201703D  
Date of Production: 21-Mar-17

Nominal Equivalent Vapor Concentration: 0.04 g/210 L vapor

Reference Solution Concentration: 0.4820 g/L or 0.04820 g/100 mL

Expanded Uncertainty of CRM (k=2):  $\pm$  0.0012 g/L or  $\pm$  0.00012 g/100 mL

Standard Uncertainty of CRM ( $u_{RM}$ ) = EU/2 =  $\pm$  0.00006 g/100 mL

Equivalent Vapor Concentration (Reference Value): 0.0398 g/210 L

Partition Coefficient for this Calculation: 1.21

Combined Equivalent Vapor Concentration Uncertainty =  $\pm$  0.0004 g/210 L

Expanded Equivalent Vapor Concentration Uncertainty =  $\pm$  0.0008 g/210 L  
(k=2, , 95.45% confidence interval)

Note: Reference Solution Concentration in g/100 mL and its Uncertainty are calculated to five decimal places.  
Equivalent Vapor Concentration and Uncertainty have been rounded to four decimal places.

Entered by: /S/ Amanda Black Date: 3/21/2019

Verified by:  Date: 3-21-19

Calculation Method: By Excel  
Verification Method: By hand calculator

VAPOR EQUIVALENT CONCENTRATION AND UNCERTAINTY

Provider: ACS  
 Lot Number: 201703D  
 Date of Production: 2017.03.21

Nominal Equivalent Vapor Concentration: 0.04 g/210 L vapor

Reference Solution Concentration: 0.4840 g/L or 0.04840 g/100 mL

Expanded Uncertainty of CRM (k=2) :  $\pm$  0.0012 g/L or  $\pm$  0.00012 g/100 mL

Standard Uncertainty of CRM ( $u_{RM}$ ) =  $EU/2 =$   $\pm$  0.00006 g/100 mL

Equivalent Vapor Concentration (Reference Value): 0.0400 g/210 L

Partition Coefficient for this Calculation: 1.21

Combined Equivalent Vapor Concentration Uncertainty =  $\pm$  0.0004 g/210 L

Expanded Equivalent Vapor Concentration Uncertainty =  $\pm$  0.0008 g/210 L  
 (k=2, , 95.45% confidence interval)

Note: Reference Solution Concentration in g/100 mL and its Uncertainty are calculated to five decimal places.  
 Equivalent Vapor Concentration and Uncertainty have been rounded to four decimal places.

Entered by: /S/ Mary Kellar Date: 7/18/2018

Verified by: /S/ Gene P Lawrence Date: 7/18/2018

Calculation Method: By Excel  
 Verification Method: By hand calculator

*Solution concentration (ACS COA) corrected to analytical (lot-specific) concentration. AB 3/21/19  
 See corrected sheet dated 3/21/19.*

VAPOR EQUIVALENT CONCENTRATION AND UNCERTAINTY

This form calculates the equivalent vapor concentration of a certified reference material solution and its uncertainty for use in the calibration of breath test instruments. These values are used to calculate the uncertainty of the measurand, the measured concentration as determined by the instrument in that calibration process.

Provider: ACS  
 Lot Number: 201703D  
 Date of Production: 2017.03.21

Nominal Equivalent Vapor Concentration: 0.04 g/210 L vapor

Reference Solution Concentration: 0.4840 g/L or 0.04840 g/100 mL

Expanded Uncertainty of CRM (k=2) :  $\pm$  0.0012 g/L or  $\pm$  0.00012 g/100 mL

Standard Uncertainty of CRM ( $u_{RM}$ ) = EU/2 =  $\pm$  0.00006 g/100 mL

Equivalent Vapor Concentration (Reference Value): 0.0400 g/210 L

Partition Coefficient for this Calculation: 1.21

Combined Equivalent Vapor Concentration Uncertainty =  $\pm$  0.0004 g/210 L

Expanded Equivalent Vapor Concentration Uncertainty =  $\pm$  0.0008 g/210 L  
 (k=2, , 95.45% confidence interval)

Note: Reference Solution Concentration in g/100 mL and its Uncertainty are calculated to five decimal places.  
 Equivalent Vapor Concentration and Uncertainty have been rounded to four decimal places.

Entered by: /S/ Mary Kellar Date: 7/9/2018

Verified by: /S/ Gene P Lawrence Date: 7/10/2018

Calculation Method: By Excel  
 Verification Method: By hand calculator

Traceability is ensured by maintaining the Certificate of Analysis provided by the manufacturer of this Certified Reference Material documenting traceability to NIST .

*Wrong worksheet form used  
 Effective date of 4/30/2018  
 Corrected on 7/18/2018 with the current approved form with  
 Effective date of 4/15/2018.*

*Solution concentration (ACS COA) corrected to  
 analytical (lot-specific) concentration. AB 3/21/19  
 See corrected sheet dated 3/21/19.*

## Reference Material Certificate

|                            |                                  |
|----------------------------|----------------------------------|
| Product identification :   | Alcohol Reference Solution (ARS) |
| CRM :                      | Ethanol in aqueous solution      |
| Reference concentration :  | 0.484 g/L                        |
| Analytical concentration : | 0.482 g/L                        |
| Lot number :               | 201703D                          |
| Date of production :       | 2017.03.21                       |

This certificate covers the production, analysis and certification of the Certified Reference Material (CRM) manufactured by Alcohol Countermeasure Systems Corp.(ACS), located at 60 International Boulevard, Toronto, ON M9W 6J2 CANADA.

This metrology laboratory is accredited in accordance with international standards ISO/IEC 17025:2005 for competence of testing and calibration laboratories, and ISO/IEC 17034:2016 for reference materials production and certification, demonstrating technical competence within the defined scope and the operation of a laboratory quality management system.

The analysis for certification of each lot of ARS is conducted within ACS forensic laboratory by an independent chemist using the direct injection, flame ionization gas chromatographic procedure coupled with the internal standard technique commensurate with forensic alcohol analysis.

This certificate is valid only for the ARS lot number identified above and does not extend to any other production lot of alcohol reference solution.

This certificate may only be reproduced in full.



For and on behalf of the company,  
ALCOHOL COUNTERMEASURE  
SYSTEMS CORP.

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Felix JE Comeau, B.Sc (Honours)  
Laboratory Director

### Certified Value

The ARS identified by lot number and date of production on the first page of this certificate was produced for the reference concentration as noted within an expanded uncertainty range of  $\pm 0.0012$  g/L.

The ARS is a Certified Reference Material (CRM), where the underlying processes for production and verification of the CRM properties are certified through ISO/IEC 17025:2005 (#4169.01) and ISO 17034:2016 (#4169.02) International Standards.

The CRM properties (analytical concentration) of the ARS was determined by a direct injection, flame ionization, gas-chromatographic procedure coupled with the internal standard technique commensurate with forensic alcohol analysis.

The homogeneity of this CRM was determined and the uncertainty inherent to sample heterogeneity is included within the expanded uncertainty.

The stability of the concentration of this CRM as packaged within high density polyethylene with hermetically sealed neck seal was determined to be within  $\pm 1$  percent over two years when stored in ambient conditions of  $+15$  to  $+25$  °C.

The analysis of the ARS and evaluation of the results was completed by an independent (third party) chemist, G.J. Kupferschmidt, B.Sc., M.Sc., MCIC, C. Chem.

The ARS will provide an equivalent vapour alcohol concentration when used in a breath alcohol simulator heated to  $34 \pm 0.2$  °C according to its analytical concentration. established by Harger (1950) and Dubowski (1979) as illustrated in the table below.

| Property (g/L) | Value (g/dL) |
|----------------|--------------|
| 0.242          | 0.020        |
| 0.605          | 0.050        |
| 1.210          | 0.100        |
| 1.815          | 0.150        |

### Uncertainty Factors of Analytical Verification

Uncertainties related to the CRM property value are specific to the laboratory technique for analytical verification employed. ACS forensic laboratory employs the use of gas chromatographic procedure as described above to analytically verify the CRM property values. The laboratory use of an internal standard technique eliminates the uncertainties related to: changes in gas chromatograph injection volume, small variations in preparation of internal standard and other test solutions. Primary uncertainty in the CRM property value results from use of NIST SRM in the gas chromatographic analysis and internal standard procedure. The final uncertainty of the CRM is nearly identical to that of the specific NIST SRM used to verify the property values. Stated uncertainty for the CRM is  $\pm 1.2\%$  at confidence level of  $k=2$ , of nominal value. Traceability of the CRM property values are analytically verified and traceable to NIST Ethanol-Water Solution.

### Standard Reference Material from NIST

- NIST SRM : 2892, 2893, 2894, 2895, 2896

Laboratory processes are traceable and verified through ISO/IEC 17025:2005 and ISO 17034:2016 International Standards.

This CRM consists of a solution of ethanol in water, prepared using a volumetric method and analyzed by the gas chromatography technique using a flame ionization detector, with direct injection procedure, and having n-Propanol as the internal standard.

The CRM is produced in a 1250 L batch lot and bottled in 2400 HDPE plastic bottles of 500 mL each with a hermetically sealed polyethylene neck seal and tamper proof cap seal.

### Analytical Method

The analysis was conducted within ACS forensic laboratory by an independent chemist using the direct injection, flame ionization gas chromatographic procedure coupled with the internal standard technique commensurate with forensic alcohol analysis.

| Property             | Value  |
|----------------------|--|
| Gas Chromatograph    | HP 5890 with integrating recorder<br>Agilent 7890A with computing software |
| Injection volume     | 2 $\mu$ L  |
| Injector temperature | 200 °C   |
| Detector type        | FID  |
| Detector temperature | 250 °C   |
| Column               | 4'x1/8" OD; 5% Carbowax 1500 on Poropak Q<br>80/100 Mesh                   |
| Column temperature   | 120 °C   |
| Carrier gas          | Nitrogen   |
| Column pressure      | 30 psi   |
|                      |  |

### Metrological Traceability

The certified value of the CRM has metrological traceability guaranteed by volumetric, primary measuring methodology and through purity of the raw materials (distilled, deionized water and absolute ethyl alcohol) used for the ARS preparation.

The analytical procedure identified above provides the traceability to NIST SRM.

### Purpose

This CRM is intended to be used for calibration verification of breath alcohol testers used to determine the concentration of ethanol in the air exhaled from the lungs.

### **Storage and Handling**

- The CRM must be stored away from sunlight and in an ambient temperature between +15 and +25 °C.
- Do not use the CRM if the bottle, cap or neck seal is compromised
- The CRM must be used within 24 hours after opening the bottle.
- The CRM is non flammable nor toxic due to its low ethanol concentration.

### **Expiry Date**

The CRM has a shelf life of two years. This CRM must be handled and stored according to the instructions in this certificate. The certificate shall not be valid in case the CRM is damaged, contaminated or altered. ACS guarantees the integrity of this material up to the moment the inner neck is removed from its 500 mL bottle. The contents of the bottle must be used immediately after it is opened.

### **Note**

All information related to the transportation and safety (MSDS) may be requested from Alcohol Countermeasure Systems.

### **References**

R.N. Harger, B.B. Raney, E.G. Bridwell, M.F. Kitchel, "The partition ratio of alcohol between air and water, urine and blood; estimation and identification of alcohol in these liquids from analysis of air equilibrated with them", J. Biological Chemistry, 183(1950)197-213

K.M. Dubowski, "Breath-alcohol simulators: scientific basis and actual performance", J. Anal. Toxicol. 3(1979)177-182.

K.M. Dubowski, N.A. Essary, "Evaluation of commercial breath-alcohol simulators: further studies", J. Anal. Toxicol., 15(1991)272-275

K.M. Dubowski, E.E. Goodson, McBeth Sample, Jr., "Storage stability of simulator ethanol solutions for vapor-alcohol control tests in breath-alcohol analysis", J. Anal. Toxic., 26(2002)406-410.