CERTIFICATE OF ANALYSIS

Single-Element Metallo-Organic CRM

Bismuth (Bi) – 1000 µg/g

Matrix: 75 cSt Hydrocarbon Oil

Product #: VHG-OBI-1000-200G Lot #: 1009866-5

Element	Certified Concentration & Uncertainty
Bi	**1000 ± 10 µg/g**

Intended Use: This solution is intended for use as a certified reference material or calibration standard for the analysis of this element in petroleum products or other organic matrices using inductively coupled plasma optical emission spectroscopy (ICP-OES), inductively coupled plasma mass spectrometry (ICP-MS), rotating disc electrode atomic emission spectroscopy (RDE-AES), flame or furnace atomic absorption spectroscopy (AA or GFAA), and other techniques for elemental analysis.

Certification & Traceability: VHG CRMs are manufactured and certified under a quality management system that is accredited to **ISO 9001**, **ISO Guide 34** and **ISO/IEC 17025**. This CRM was prepared to the certified concentration shown above by gravimetric methods using a single-element concentrate that is traceable to the NIST SRM listed below. The balances used in the preparation of VHG CRMs are calibrated regularly with traceability to NIST. The certified concentration was determined by VHG Labs based upon gravimetric procedures. Secondary verification of the certified concentration was performed by VHG Labs using ICP-OES and these data are traceable to **NIST SRM 3106**. The uncertainty associated with the certified concentration represents the expanded uncertainty at the 95% confidence level using a coverage factor of k=2.

Uncertified Values: ICP-OES was used to determine trace metal concentrations in this product.

Trace Concentrations (µg/g)

Ag	<1	Cr	<1	Mo	<1	Sn	<1
Al	<1	Cu	<1	Na	<1	Sr	<1
As	<1	Fe	<1	Ni	<1	Ti	<1
B	<1	Hg	<1	P	<1	Tl	<1
Ba	<1	K	<1	Pb	<1	V	<1
Bi	Major	La	<1	Sb	<1	Y	<1
Ca	<1	Li	<1	Sc	<1	Zn	<1
Cd	<1	Mg	<1	Se	<1		
Co	<1	Mn	<1	Si	<1		

Instructions for Use: We recommend that the solution be thoroughly mixed by repeated shaking or swirling of the bottle immediately prior to use. To achieve the highest accuracy the analyst should: (1) use only pre-cleaned containers and transferware, (2) not pipette directly from the CRM's original container, (3) use a minimum sub-sample size of 500mg, (4) make dilutions using calibrated balances or certified volumetric class A flasks and pipettes, (5) dilute with the same matrix as the original CRM, and (6) never pour used product back into the original container. The solution should be kept tightly capped and stored under normal laboratory conditions. Fresh solutions should be prepared daily. Do not freeze, heat, or expose to direct sunlight. Minimize exposure to moisture or high humidity.

Period of Validity: VHG ensures the accuracy of this solution for **12 Months** from the certification date shown below, provided the instructions for use are followed. Any dilutions to lower concentrations may have reduced storage life. During the period of validity, the purchaser will be notified if this product is recalled due to any significant changes in the stability of the solution.

VHG Labs, Inc.

Chuck Goudreau, Certifying Officer

See Exp. Date on Container
Certification Date

LGC waives all responsibility for any damages resulting from the usage and/or implementation of the products/data described herein.

ACCREDITED
REFERENCE MATERIALS
PRODUCER CERT #2848.02
CHEMICAL TESTING
CERT #2848.01

Rev 1

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ISO 9001
ISO Guide 34
ISO/IEC 17025
ISO/IEC 17043

Hazardous Information: Refer to the Material Safety Data Sheet (MSDS), which can be obtained at www.vhglabs.com.

Homogeneity: This solution was determined to be homogeneous by procedures consistent with the requirements of ISO Guide 34 and ISO Guide 35. Replicate samples of the finished solution were analyzed to confirm its homogeneity, in accordance with VHG QSP 6-13 Assessment of Homogeneity and Stability. To ensure homogeneity, users should not take a smaller sub-sample than specified in the Instructions for Use, as doing so will invalidate the certified values and uncertainties.

Further Information: Please contact VHG Labs for further information about this CRM.

Quality Certifications: This CRM was prepared under a quality management system that is accredited to the following:

- ISO 9001 – Quality Management Systems – Requirements (Registrar: United Registrar Services, LLC)
- ISO/IEC 17025 – General Requirements for the Competence of Testing and Calibration Laboratories
- ISO Guide 34 – General Requirements for the Competence of Reference Material Producers
    - ISO Guide 34 references additional requirements specified in ISO Guide 31 and ISO Guide 35.

VHG Custom Standards are Traceable to the Following NIST SRMs:

Analyte	Aq. SRM	MO SRM		Analyte	Aq. SRM	MO SRM		Analyte	Aq. SRM	MO SRM
Ag	3151	1077a		Hf	3122	—		S	3154	2770
Al	3101a	1075a		Hg	3133	3133		Sb	3102a	3102a
As	3103a	3103a		Ho	3123a	—		Sc	3148a	3148a
Au	3121	—		In	3124a	3124a		Se	3149	3149
B	3107	3107		K	3141a	3141a		Si	3150	1066a
Ba	3104a	1051b		La	3127a	3127a		Sm	3147a	—
Be	3105a	3105a		Li	3129a	3129a		Sn	3161a	1057b
Bi	3106	3106		Lu	3130a	—		SO_4^{-2}	3181	—
Br^-	3184	—		Mg	3131a	3131a		Sr	3153a	3153a
Ca	3109a	3109a		Mn	3132	3132		Ta	3155	—
Cd	3108	1053a		Mo	3134	3134		Tb	3157a	—
Ce	3110	3110		Na	3152a	1069b		Te	3156	—
Cl^-	3182	1818a		Nb	3137	—		Th	3159	—
Co	3113	3113		Nd	3135a	—		Ti	3162a	3162a
Cr	3112a	1078b		Ni	3136	1065b		Tl	3158	3158
Cs	3111a	—		NO_3^-	3185	—		Tm	3160a	—
Cu	3114	1080a		P	3139a	3139a		U	3164	—
Dy	3115a	—		Pb	3128	1059c		V	3165	1052b
Er	3116a	—		Pd	3138	—		W	3163	3163
Eu	3117a	—		PO_4^{-3}	3186	—		Y	3167a	3167a
F^-	3183	—		Pr	3142a	—		Yb	3166a	—
Fe	3126a	1079b		Pt	3140	3140		Zn	3168a	3168a
Ga	3119a	—		Rb	3145a	—		Zr	3169	3169
Gd	3118a	—		Re	3143	—				
Ge	3120a	—		Rh	3144	3144				