CERTIFICATE OF ANALYSIS

VHG Labs Quality Product

Single-Element Aqueous CRM

Cerium (Ce) – 1000 µg/mL — Product #: VHG-PCEN-250

Matrix: 5% HNO_3 — Lot #: 1045447-22

Element	Certified Concentration & Uncertainty
Ce	**995 ± 5 µg/mL (w/v)**
	992 ± 5 µg/g (w/w)

Intended Use: This solution is intended for use as a certified reference material (CRM) or calibration standard for inductively coupled plasma optical emission spectroscopy (ICP-OES), inductively coupled plasma mass spectrometry (ICP-MS), flame or furnace atomic absorption spectroscopy (AA or GFAA), and other techniques for elemental analysis.

Certification & Traceability: VHG Labs CRMs are manufactured, processed, and certified under a quality management system that is registered/accredited to **ISO 9001**, **ISO Guide 34**, and **ISO/IEC 17025**. This CRM was prepared to a nominal concentration of 1000 µg/mL by gravimetric methods using 99.999% pure cerium (III) nitrate hexahydrate [$Ce(NO_3)_3$ $6H_2O$] dissolved in high purity nitric acid (HNO_3) and diluted with filtered (0.22µm), 18 M-ohm deionized water. The balances used in the preparation of VHG CRMs are calibrated regularly with traceability to NIST, using a calibration provider that is accredited to ISO/IEC 17025 by a mutually recognized accreditation body. All volumetric dilutions are performed in Class A calibrated glassware. The certified concentration and uncertainty were determined by VHG using the "High Performance ICP-OES" protocol developed by NIST (visit www.lgcstandards.com/HP-ICP-OES for further information), and both the certified concentration and uncertainty values are traceable to **NIST SRM 3110, lot #090504**. The uncertainty associated with the certified concentration represents the expanded uncertainty at the 95% confidence level using a coverage factor of k=2. The expanded uncertainty will increase at a rate of 0.008% per month after the Stable-Pak™ bag is opened.

Indicative Values: ICP-MS was used to determine trace metal concentrations for this product (nd = not determined).

Trace Concentrations (µg/L)

Ag	<0.5	Co	<1	Ge	<0.5	Lu	<0.2	P	<100	Sb	<0.5	Te	<1
Al	3	Cs	3	Hf	<0.2	Mg	<5	Pb	<1	Sc	<5	Ti	<2
As	<2	Cr	5	Hg	<0.5	Mn	<1	Pd	<0.5	Se	<2	Tl	<0.5
Au	<0.5	Cu	<1	Ho	<0.2	Mo	<0.5	Pr	7	Si	<100	Tm	<0.2
B	<5	Dy	3	In	nd	Na	<25	Pt	<0.5	Sm	2	V	<1
Ba	3	Er	10	Ir	<0.2	Nb	<0.5	Rb	<0.5	Sn	<0.5	W	<0.5
Bi	0.7	Eu	<0.2	K	<25	Nd	<0.2	Re	<0.2	Sr	<1	Y	<0.5
Ca	<25	Fe	18	La	1	Ni	3	Rh	<0.5	Ta	<0.5	Yb	<0.2
Cd	<0.5	Ga	<10	Li	<2	Os	<0.5	Ru	<0.5	Tb	<2	Zn	<2
Ce	MAJOR	Gd	5										

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) never pour used product back into the original container, (4) make dilutions using calibrated balances or certified class A volumetric flasks and pipettes, (5) use a minimum sub-sample size of 500 µL, and (6) dilute with the same matrix as the original CRM or other chemically suitable matrix. The solution should be kept tightly capped and stored under normal laboratory conditions. Do not freeze, heat, or immerse the bottle or its contents, and avoid exposure to direct sunlight or moisture.

Period of Validity: LGC ensures the accuracy of this solution for **24 months** from the certification date shown below or **12 months** from the date the Stable-Pak™ bag is opened, provided the instructions for use are followed. 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.

Chuck Goudreau, Certifying Officer

See Exp. Date on Container
Certification Date

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

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

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

Health and Safety Information: Refer to the Safety Data Sheet (SDS), which can be obtained at www.lgcstandards.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.

Quality Manual Rev: No. 5, 03/01/2013

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

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

- ISO 9001 – Quality Management Systems – Requirements (Registrar: TUV NORD)
- 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.