



National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material[®] 3109a

Calcium Standard Solution

Lot No. 000613

This Standard Reference Material (SRM) is intended for use as a primary calibration standard for the quantitative determination of calcium. One unit of SRM 3109a consists of 50 mL of an acidified aqueous solution prepared gravimetrically to contain a known mass fraction of calcium. The solution contains nitric acid at a volume fraction of approximately 10 %. The SRM is packaged in a high density polyethylene bottle sealed in an aluminized bag.

Certified Value of Calcium: 10.397 mg/g \pm 0.019 mg/g

The certified value is based on (1) gravimetric preparation using high purity calcium carbonate and (2) inductively coupled plasma optical emission spectrometry (ICP-OES) using independently prepared primary standards. The certified value has been adjusted upward by 0.08 % relative to compensate for the effect of transpiration losses of solvent through the container walls during the period of validity of the *unopened* SRM. *No correction has been applied for transpiration that will occur after the SRM bottle unit has been removed from the sealed bag.* See "Instructions for Use" for more information regarding transpiration.

The uncertainty in the certified value is calculated as

$$U = ku_c$$

where $k = 1.97$ is the coverage factor for a 95 % expanded uncertainty. The quantity u_c is the combined standard uncertainty calculated according to the *ISO Guide* [1]. The value of u_c is intended to represent, at a level of one standard deviation, the combined effect of uncertainty components associated with the gravimetric preparation, the ICP-OES determination, the transpiration correction, and method bias [2]. The uncertainty of the transpiration correction has been modeled as a uniform probability distribution covering a 4 year period of validity in which the maximum expected transpiration varies between 0 % and 0.16 %. After normalization, the standard uncertainty of the transpiration correction is 0.046 % relative.

Expiration of Certification: The certification of **SRM 3109a Lot No. 000613** is valid, within the measurement uncertainty specified, until **01 June 2004**, provided the SRM is handled in accordance with instructions given in this certificate (see Instructions for Use). This certification is nullified if the SRM is damaged, contaminated, or modified.

Maintenance of Certification: NIST will monitor representative solutions from this SRM lot over the period of its certification. If substantive changes occur that affect the certification before the expiration of certification, NIST will notify the purchaser. Return of the attached registration card will facilitate notification.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by J.C. Colbert.

Willie E. May, Chief
Analytical Chemistry Division

Gaithersburg, MD 20899
Certificate Issue Date: 16 July 2001

John Rumble, Jr., Acting Chief
Standard Reference Materials Program

Coordination of the technical measurements leading to the certification of SRM 3109a was provided by G.C. Turk of the NIST Analytical Chemistry Division. This SRM was prepared by T.A. Butler and analyzed using ICP-OES by G.C. Turk and T.A. Butler of the NIST Analytical Chemistry Division. Primary standards for ICP-OES calibration were prepared by B.R. Norman and C.M. Beck II of the NIST Analytical Chemistry Division.

Statistical consultation was provided by S.D. Leigh of the NIST Statistical Engineering Division.

TRACEABILITY TO THIS SRM

Calibration of analytical instruments or procedures for the determination of calcium should be performed using standards that are traceable to this SRM. The traceability of standards to this SRM must be established through an unbroken chain of comparisons, each having stated uncertainties [3]. Comparisons are based on physical or chemical measurements proportional to calcium concentration. These may include various spectroscopic or classical methods of analysis. Gravimetric or volumetric dilution is also a method of comparison, where the mass or volume of a solution before and after dilution is measured. The uncertainties assigned to such traceable standards must include the uncertainty of this SRM appropriately combined with the uncertainties of all comparison measurements.

INSTRUCTIONS FOR USE

This SRM can be used to prepare *working standard solutions* in the range of 10 mg/kg to 100 mg/kg, from which more dilute standards are prepared. The user should establish internal laboratory procedures that specify a maximum shelf life for a working standard solution. Two procedures for the preparation of working standard solutions follow.

Preparation of Working Standard Solutions by Mass: Each working standard solution should be prepared by transferring an aliquot of the SRM to an empty, dry, preweighed polyethylene bottle, and then reweighing the bottle. An appropriate dilute acid must be added by mass to bring the solution to the approximate desired dilution. The dilution need not be exact since the mass of the empty bottle, mass of the bottle plus SRM aliquot, and the final diluted mass of the solution will permit calculation of the exact concentration of the working solution. Dilutions prepared gravimetrically as described will need no correction for temperature and no further correction for true concentration in vacuum. The working standard solution concentration will be in mg/kg units. Volumetric dilutions are **NOT** recommended due to uncertainties in volume calibrations and variations in density. However, for user convenience, a procedure for volumetric preparation that will minimize the major sources of error is given below.

Preparation of Working Standard Solutions by Volume: Each working standard solution should be prepared by transferring an aliquot of the SRM to an empty, dry polyethylene bottle and then weighing the bottle. The solution must now be transferred to a Class A volumetric flask and the polyethylene bottle reweighed to determine the exact mass of SRM solution transferred. The solution in the flask is then diluted to 99 % + of volume using an appropriate dilute acid, mixed thoroughly, and the remaining few drops needed to dilute to exact volume carefully added. The concentration (in mg/mL) of the resulting working standard solution can then be calculated by multiplying the mass (in g) of the SRM solution amount by the SRM certified value (in mg/g), and dividing the numerical product by the calibrated volume (in mL) of the flask used for dilution. Thus, no correction for density is needed, and although the concentration of the resulting working standard solution may be an uneven fraction of the original SRM concentration, it will be known as accurately as a volumetric dilution permits.

Transpiration: After the SRM has been removed from the aluminized bag, transpiration will occur at an accelerated rate of approximately 0.2 % relative per year, resulting in a gradual increase in the element mass fraction. It is the responsibility of the user to account for this effect. The recommended way to reduce the effects of transpiration is to begin the preparation of all working standard solutions by delivering weighed aliquots of the SRM to appropriate vessels as soon as the SRM is removed from the aluminized bag. The aliquots may be stored and can be diluted to known mass or volume at a later date. Storage of a partially used SRM bottle is **NOT** recommended; however, if such storage is necessary, the cap should be tightly sealed and the SRM bottle kept in an airtight container to slow the rate of transpiration. When the bottle is weighed both before and after being placed in storage, the mass difference observed will be a measure of transpiration mass loss. The user should set a maximum shelf life *for a partially used SRM bottle* commensurate with accuracy requirements.

REFERENCES

- [1] *Guide to the Expression of Uncertainty in Measurement*, ISBN 92-67-10188-9, 1st Ed., ISO, Geneva, Switzerland, (1993); see also Taylor, B.N. and Kuyatt, C.E., "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," NIST Technical Note 1297, U.S. Government Printing Office, Washington DC, (1994); available at <http://physics.nist.gov/Pubs/>.
- [2] Levenson, M.S., Banks, D.L., Eberhardt, K.R., Gill, L.M., Guthrie, W.F., Liu, H-k., Vangel, M.G., Yen, J.H., and Zhang, N.F., "An Approach to Combining Results From Multiple Methods Motivated by the ISO Guide," *J. Res. Natl. Inst. Stand.* 105, 521 (2000).
- [3] *International Vocabulary of Basic and General Terms in Metrology*, ISBN 92-67-01075-1, 2nd Ed., ISO, Geneva, Switzerland, (1993).

Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet <http://www.nist.gov/srm>.