



Certificate of Analysis

Standard Reference Material[®] 3186

Phosphate Anion (PO₄³⁻) Standard Solution

Lot No. 170606

This Standard Reference Material (SRM) is intended as a primary calibration standard for the quantitative determination of phosphate using anion ion chromatography (IC) or other methods. A unit of SRM 3186 consists of five 10 mL sealed borosilicate glass ampoules of solution prepared gravimetrically to contain a known mass fraction of phosphate dissolved in filtered (0.22 μm) water having a minimum resistivity of 18 MΩ cm.

Certified Value of Phosphate: 1.0005 mg/g ± 0.0041 mg/g

The certified value was calculated as the weighted mean of the mass fraction values obtained through (1) gravimetric preparation using high-purity potassium dihydrogen phosphate (SRM 200b) and (2) analysis by anion IC calibrated using primary standard solutions independently prepared from high-purity potassium dihydrogen phosphate (SRMs 200a and 200b) and ammonium dihydrogen phosphate (SRMs 194 and 194a) [1-3]. A NIST certified value is a value for which NIST has the highest confidence in its accuracy in that all known or suspected sources of bias have been investigated or taken into account [4].

The uncertainty associated with the certified value, stated as a symmetric interval with a level of confidence of approximately 95 %, was evaluated in accordance with Supplement 1 to the ISO/JCGM Guide [5]. The uncertainty can be expressed as

$$U = ku_c$$

where $k = 2.284$ is the coverage factor for a 95 % confidence interval and 8.46 effective degrees of freedom. The quantity u_c is the combined standard uncertainty that represents, at the level of one standard deviation, the combined effect of uncertainty components associated with the gravimetric preparation, the IC determination, any difference between the methods' results, and stability of the actual phosphate mass fraction.

Expiration of Certification: The certification of **SRM 3186 Lot No. 170606** is valid, within the measurement uncertainty specified, until **30 June 2025**, provided the SRM is stored and handled in accordance with instructions given in this certificate (see "Instructions for Handling, Storage, and Use"). This certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before the expiration of certification, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

Coordination of the technical measurements leading to the certification of SRM 3186 was provided by T.W. Vetter of the NIST Chemical Sciences Division.

This SRM was prepared by T.A. Butler of the NIST Chemical Sciences Division. IC analyses were performed by B.E. Lang of the NIST Chemical Sciences Division using primary standard solutions for IC calibration prepared by T.A. Butler and B.E. Lang.

Carlos A. Gonzalez, Chief
Chemical Sciences Division

Gaithersburg, MD 20899
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Certificate Revision History on Last Page

Steven J. Choquette, Director
Office of Reference Materials

Statistical consultation was provided by A.M. Possolo of the NIST Statistical Engineering Division.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

METROLOGICAL TRACEABILITY

Metrological traceability of measurement results to a given reference must be established through an unbroken chain of calibrations and/or comparisons, each having stated uncertainties [6], using measurement standards that are appropriate for the physical or chemical property being measured. Comparisons may include validation measurements using various spectroscopic, chromatographic 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.

For this SRM, the measurand is the total mass fraction of phosphate and the certified value is metrologically traceable to the derived SI unit for mass fraction. This SRM can be used to establish traceability of the results of phosphate measurements to NIST measurement results and standards. One approach is to calibrate analytical instruments or procedures for the determination of phosphate using standards whose values are traceable to the certified value of phosphate in this SRM. When the traceable values of such standards are assigned using this SRM for calibration, the uncertainties assigned to those values must include the uncertainty of the certified value of this SRM, appropriately combined with the uncertainties of all calibration measurements.

INSTRUCTIONS FOR HANDLING, STORAGE, AND USE

CAUTION: This SRM is a solution contained in tip-sealed borosilicate glass ampoules with pre-scored stems. All appropriate safety precautions, including use of gloves during handling, should be taken. Unopened ampoules should be stored upright under normal laboratory conditions inside the original container supplied by NIST.

Opening an Ampoule: When an ampoule is to be opened, that area of the stem where the pre-scored band is located (≈ 5 mm below the encircling metallic band) should be carefully wiped with a clean, damp cloth and the body of the ampoule wrapped in absorbent material. Holding the ampoule steady and with thumb and forefinger grasping the stem at the metallic band, **minimal** thumb pressure should be applied to the stem to snap it. Correctly done, the stem should break easily where pre-scored. Use of a metal file to break the stem is **NOT** recommended.

Working Standard Solutions: After opening the ampoule, the contents should be transferred immediately to another container and *working standard solutions* should be prepared. Working standard solutions in the range of 10 mg/kg to 100 mg/kg are recommended, from which more dilute standards can be 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 emptying one or more ampoules of the SRM into an empty, dry, pre-weighed, polyethylene bottle and then reweighing the bottle. Water of appropriate purity must be added by mass to bring the solution to the 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 mass fraction (i.e., mass of phosphate per mass of solution) of the working standard solution. Dilutions prepared gravimetrically as described will need no correction for temperature and no further correction for true mass fraction in vacuum.

Preparation of Working Standard Solutions by Volume: Volumetric dilutions are **NOT** recommended because of 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. Each working standard solution should be prepared by emptying one or more ampoules of the SRM into 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 must be reweighed to determine the exact mass of SRM solution transferred. The solution in the flask is then diluted to 99 % + volume using water of appropriate purity, mixed thoroughly, and the remaining few drops needed to dilute to exact volume carefully added. The mass concentration (in milligrams per milliliter) of the resulting working standard solution can then be calculated by multiplying the mass (in grams) of the SRM solution amount by the SRM certified value (in milligrams per gram) and dividing the numerical product by the calibrated volume (in milliliters) of the flask used for dilution. If this procedure is followed, no correction for density is needed. Although the mass concentration of the resulting working standard solution may be an uneven fraction of the original SRM mass concentration, it will be known as accurately as a volumetric dilution permits.

Possible Presence of Other Elements: Studies conducted by NIST have shown that components of borosilicate glass ampoules may leach into solution. In *undiluted* solutions, Na and Si mass fractions as large as 20 mg/kg, B and La mass fractions in the range 1 mg/kg to 5 mg/kg, and Al, As, Ca, Ce, Mg, Mn, Rb, and Zn mass fractions in the range 0.05 mg/kg to 1 mg/kg have been found. When diluted to prepare working standard solutions, the levels of these elements become negligible for most purposes. Nevertheless, possible effects should be considered when this SRM is used.

NOTICE TO USERS

NIST strives to maintain the SRM inventory supply, but NIST cannot guarantee the continued or continuous supply of any specific SRM. Accordingly, NIST encourages the use of this SRM to validate or otherwise assign values to the more routinely used standards in a laboratory. When the metrologically traceable values of such standards are assigned using this SRM for calibration, the uncertainties assigned to those values must include the uncertainty of the certified value of this SRM, appropriately combined with the uncertainties of the calibration measurements for the in-house standard. Comparisons between NIST SRMs and such working measurement standards should take place at intervals appropriate to the conservation of the SRM and the stability of relevant in-house standards. For further guidance on how this approach can be implemented, contact NIST by email at srms@nist.gov.

REFERENCES

- [1] Rukhin, A.L.; *Weighted Means Statistics in Interlaboratory Studies*; Metrologia, Vol. 46; pp. 323–331 (2009).
- [2] DerSimonian, R.; Laird, N.; *Meta-Analysis in Clinical Trials*; Control. Clin. Trials, Vol. 7; pp. 177–188 (1986).
- [3] Koepke, A., Lafarge, T., Possolo, A, and Toman, B.; *Consensus Building for Interlaboratory Studies, Key Comparisons, and Metal-Analysis*, Metrologia, Vol. 54, pp. S34–S62 (2017).
- [4] May, W.; Parris, R.; Beck, C.; Fassett, J.; Greenberg, R.; Guenther, F.; Kramer, G.; Wise, S.; Gills, T.; Colbert, J.; Gettings, R.; MacDonald, B.; *Definitions of Terms and Modes Used at NIST for Value-Assignment of Reference Materials for Chemical Measurements*; NIST Special Publication 260-136; U.S. Government Printing Office: Washington, DC (2000); available at <https://www.nist.gov/system/files/documents/srm/SP260-136.PDF> (accessed Jun 2021).
- [5] JCGM 101:2008; *Evaluation of Measurement Data — Supplement 1 to the “Guide to the Expression of Uncertainty in Measurement” — Propagation of Distributions using a Monte Carlo Method*; JCGM (2008); available at <https://www.bipm.org/en/publications/guides> (accessed Jun 2021).
- [6] JCGM 200:2012; *International Vocabulary of Metrology — Basic and General Concepts and Associated Terms*; 3rd ed.; JCGM (2012); available at <https://www.bipm.org/en/publications/guides> (accessed Jun 2021).

Certificate Revision History: 03 June 2021 (Change of expiration date; editorial changes); 16 January 2018 (Original certificate date).
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Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; e-mail srminfo@nist.gov; or via the Internet at <https://www.nist.gov/srm>.