NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

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Standard Reference Material® 1880b
Portland Cement
CERTIFICATE OF ANALYSIS

Purpose: The certified values delivered by this Standard Reference Material (SRM) are intended primarily for the calibration or evaluation of methods for analysis of cements and materials of similar matrix.

Description: A unit of SRM 1880b consists of five sealed vials, each containing approximately 5 g of portland cement ground to pass through a 75 µm (No. 200) sieve.

Certified Values: Certified values for constituents in SRM 1880b are reported below as mass fractions [1] on an as-received basis. 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 [2]. A certified value is the present best estimate of the true value based on the results of analyses performed at NIST and collaborating laboratories using the instrumental and classical test methods listed in Appendix B.

The measurands are the mass fractions of the elements in cement listed below. Metrological traceability is to the International System of Units (SI) derived unit for mass fraction (expressed as a percent). Each certified value is the unweighted mean of the results from two to four methods. The uncertainty of a certified value is expressed as an expanded uncertainty, U, and is calculated according to the method described in the ISO/JCGM Guide [3,4]. The expanded uncertainty is $U = ku_c$, where u_c is calculated, at the level of one standard deviation, by combining a between method variance with a pooled, within method variance. The coverage factor, $k = 2$, was used corresponding to an approximately 95 % confidence level.

Certified Mass Fraction Values for SRM 1880b Portland Cement

Constituent	Mass Fraction (%)		
SiO_2	20.42	±	0.36
Al_2O_3	5.183	±	0.073
Fe_2O_3	3.681	±	0.023
CaO	64.16	±	0.40
MgO	1.176	±	0.020
SO_3[(a)]	2.710	±	0.099
Na_2O	0.0914	±	0.0052
K_2O	0.646	±	0.014
TiO_2	0.236	±	0.012
P_2O_5	0.2443	±	0.0027
Mn_2O_3	0.1981	±	0.0020
Chlorine (Cl)	0.01830	±	0.00057
Cr_2O_3 [(a)]	0.01927	±	0.00042

[(a)] The uncertainty estimates for SO_3 and Cr_2O_3 include an additional component of uncertainty of 2 % (relative) to account for greater than expected heterogeneity observed during testing of the material after packaging.

Non-Certified Values: Non-certified values are provided in Appendix A

Additional Information: Values of potential interest to users and additional information is provided in Appendix B.

Period of Validity: The certified values delivered by **SRM 1880b** are valid within the measurement uncertainty specified until **01 November 2033**. The certified values are nullified if the material is stored or used improperly, damaged, contaminated, or otherwise modified.

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Maintenance of Certified Values: NIST will monitor this SRM over the period of its validity. If substantive technical changes occur that affect the certification, NIST will issue an amended certificate through the NIST SRM website (https://www.nist.gov/srm) and notify registered users. SRM users can register online from a link available on the NIST SRM website or fill out the user registration form that is supplied with the SRM. Registration will facilitate notification. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

Safety: Consult the Safety Data Sheet (SDS) for hazard information.

Use: Cement powder is hygroscopic. Samples should be used immediately after opening the vial to minimize changes from reaction with moisture and carbon dioxide in air. To relate analytical determinations to the certified values in this Certificate of Analysis, a minimum test portion of 500 mg should be used. The vial should be recapped immediately, placed back in the labeled foil pouch, and stored in a desiccator.

When a sample is used after storage in a previously opened vial, the loss on ignition (LOI) at 950 °C value for that sample should be determined in accordance with ASTM C114 Standard Test Methods for Chemical Analysis of Hydraulic Cement [5] and the mass of the sample corrected for any increase above the value reported in Table A1 for LOI total at 950 °C. See Appendix A for more information about LOI of portland cement.

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 as a primary benchmark for the quality and accuracy of the user's in-house reference materials and working standards. As such, the SRM should be used to validate the more routinely used reference materials in a laboratory. Comparisons between the SRM and in-house reference materials or working measurement standards should take place at intervals appropriate to the conservation of the SRM and the stability of relevant in-house materials. For further guidance on how this approach can be implemented, contact NIST by email at srms@nist.gov.

REFERENCES

[1] Thompson, A.; Taylor, B.N.; *Guide for the Use of the International System of Units (SI)*; NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (2008); available at https://www.nist.gov/pml/pubs/sp811/index.cfm (accessed Nov 2024).

[2] Beauchamp, C.R.; Camara, J.E.; Carney, J.; Choquette, S.J.; Cole, K.D.; DeRose, P.C.; Duewer, D.L.; Epstein, M.S.; Kline, M.C.; Lippa, K.A.; Lucon, E.; Molloy, J.; Nelson, M.A.; Phinney, K.W.; Polakoski, M.; Possolo, A.; Sander, L.C.; Schiel, J.E.; Sharpless, K.E.; Toman, B.; Winchester, M.R.; Windover, D.; *Metrological Tools for the Reference Materials and Reference Instruments of the NIST Material Measurement Laboratory*; NIST Special Publication (NIST SP) 260-136, 2021 edition; National Institute of Standards and Technology, Gaithersburg, MD (2021); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2021.pdf (accessed Nov 2024).

[3] Levenson, M.S.; Banks, D.L.; Eberhardt, K.R.; Gill, L.M.; Guthrie, W.F.; Liu, H.K.; Vangel, M.G.; Yen, J.H.; Zhang, N.F.; *An Approach to Combining Results from Multiple Methods Motivated by the ISO GUM*; J. Res. Natl. Inst. Stand. Technol., Vol. 105, pp 571–579 (2000).

[4] JCGM 100:2008; *Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement*; (GUM 1995 with Minor Corrections), Joint Committee for Guides in Metrology (JCGM) (2008); available at https://www.bipm.org/en/committees/jc/jcgm/publications (accessed Nov 2024); see also Taylor, B.N.; 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 https://www.nist.gov/pml/nist-technical-note-1297 (accessed Nov 2024).

[5] ASTM C 114-07, Standard Test Methods for Chemical Analysis of Hydraulic Cement, *Annu. Book ASTM Stand.*, Vol. 04.01, West Conshohocken, PA.

[6] Sieber, J.; Broton, D.; Fales, C.; Leigh, S.; MacDonald, B.; Marlow, A.; Nettles, S.; Yen, J.; *Standard Reference Materials for Cement*, Cement and Concrete Res., Vol. 32. Issue 12, pp 1899–1906 (2002).

Certificate Revision History: 19 November 2024 (Change of period of validity; updated format; editorial changes); 04 October 2018 (Corrected unit size; editorial changes); 25 May 2010 (Correction of reference value for Free CaO and editorial changes); 09 March 2009 (Original certificate issue date).

Certain commercial equipment, instruments, or materials may be identified in this Certificate of Analysis to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the Office of Reference Materials 100 Bureau Drive, Stop 2300, Gaithersburg, MD 20899-2300; telephone (301) 975-2200; e-mail srminfo@nist.gov; or the Internet at https://www.nist.gov/srm.

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APPENDIX A

Non-Certified Mass Fraction Values: Non-certified values are values that are the present best estimates of the true values. However, the values do not meet the NIST criteria for certification and are provided with associated uncertainties that may not include all sources of uncertainty [2]. Non-certified mass fraction values for constituents are provided in Table A1.

The measurands are the mass fractions of the chemical constituents in cement listed in Table A1 as determined by the methods indicated in Table B2.

Table A1. Non-Certified Mass Fraction Values for SRM 1880b Portland Cement

Constituent	Mass Fraction (%)
Insoluble residue[(a)]	0.487 ± 0.014
Free CaO[(a)]	1.567 ± 0.059
Fluoride (F^-)[(a)]	0.0539 ± 0.0012
SrO[(a)]	0.0272 ± 0.0016
Sulfide Sulfur[(a)]	0.0131 ± 0.0021
ZnO[(b)]	0.01054 ± 0.00034
Measurand	**Mass Fraction (%)**
LOI at 950 ºC	1.666 ± 0.011

[(a)] Each non-certified value is the mean of results obtained by a single laboratory using one analytical technique. The expanded uncertainty is calculated as $U = ku_c$ where u_c is one standard deviation of the analyte mean, and the coverage factor, $k = 2$, was used corresponding to approximately 95 % confidence level for each analyte.

[(b)] Each non-certified value is the unweighted mean of the results from two to four methods. The uncertainty of the non-certified value is expressed as an expanded uncertainty, U, and is calculated according to the method described in the ISO/JCGM Guide [3,4]. The expanded uncertainty is $U = ku_c$, where u_c is calculated, at the level of one standard deviation, by combining a between-method variance with a pooled, within-method variance. The coverage factor, $k = 2$, was used corresponding to approximately 95 % confidence level.

Maintenance of Non-Certified Values: NIST will monitor this material to the end of its period of validity. If substantive technical changes occur that affect the non-certified values during this period, NIST will update this Appendix and notify registered users. SRM users can register online from a link available on the NIST SRM website or fill out the user registration form that is supplied with the SRM. Registration will facilitate notification. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

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APPENDIX B

Preparation and Analysis: The material for SRM 1880b was obtained in the form of powder prepared using a typical industrial process. The material was blended and packaged at NIST. Homogeneity testing was performed at NIST using X-ray fluorescence spectrometry. Material heterogeneity was low and fit for the purpose of value assignment. Quantitative determinations done by NIST included X-ray fluorescence spectrometry [6] and thermogravimetric analysis and by Construction Technology Laboratories, Inc. using X-ray fluorescence spectrometry, inductively coupled plasma optical emission spectrometry, and reference methods given in reference [5]. The constituents listed in this Certificate of Analysis are expressed as the chemical forms and in the order given in ASTM C 114-07, Section 3, Table 1 [5].

Values of Potential Interest to Users: Values of potential interest to users for constituents are reported in Table B1 along with a calculated "total" value accounting for all determined constituents. A value of potential interest is considered to be a value that will be of interest and use to the SRM user, but for which insufficient information is available to assess adequately the uncertainty associated with the value, or a value derived from a limited number of analyses [2]. Values of potential interest cannot be used to establish metrological traceability.

Table B1. Values of Potential Interest to Users for SRM 1881b

Measurand	Mass Fraction (%)
LOI at 550 ºC	1.026
LOI at 220 ºC	0.478
Total[(a)]	100.49

[(a)] Three corrections have been made to the calculated total of analyzed constituents: (1) the amount of fluorine present, (2) the amount of chlorine present, and (3) the overestimation of oxygen by expressing total S as SO_3 when a quantifiable amount of sulfide sulfur is present. All three corrections were subtracted from the gross total. The correction for F was determined by multiplying the percent fluorine by the ratio of the relative atomic mass of oxygen to two times the relative atomic mass of fluorine (0.421). The correction for chlorine was determined by multiplying the percent chlorine by the ratio of the relative atomic mass of oxygen to two times the relative atomic mass of chlorine (0.226). The correction for sulfide sulfur was determined by multiplying the percent sulfide sulfur by the ratio of three times the relative atomic mass of oxygen to the relative atomic mass of sulfur (1.50).

Table B2. Analytical Methods Used on SRM 1881b Portland Cement

Constituent	Methods[a]
SiO_2	Total Si determined using XRF, ICP-OES, and gravimetry
Al_2O_3	Total Al determined using XRF and ICP-OES
Fe_2O_3	Total Fe determined using XRF and ICP-OES
CaO	Total Ca determined using XRF, ICP-OES, and gravimetry
MgO	Total Mg determined using XRF and ICP-OES
SO_3	Total S determined using XRF, ICP-OES, and gravimetry
Na_2O	Total Na determined using XRF and ICP-OES
K_2O	Total K determined using XRF and ICP-OES
TiO_2	Total Ti determined using XRF and ICP-OES
P_2O_5	Total P determined using XRF, ICP-OES and UV absorbance
ZnO	Total Zn determined using XRF
Mn_2O_3	Total Mn determined using XRF and ICP-OES
Cr_2O_3	Total Cr determined using XRF and ICP-OES
SrO	Total Sr determined using XRF and ICP-OES
Sulfide S	KIO_3 titration after reaction with HCl
Insoluble Residue	Gravimetry
Free CaO	ASTM C114-07 method performed by the collaborating laboratory
Chlorine (Cl)	Total Cl determined using XRF[b] with standard additions at NIST, and an ion-selective electrode method at the collaborating laboratory
Fluoride (F^-)	Ion-selective electrode at collaborating laboratory
Loss on Ignition (LOI)	Thermogravimetric analysis performed at NIST and the collaborating laboratory with mass loss measured at 220 ºC, 550 ºC, and 950 ºC.

[a] Key to Methods:

XRF	X-ray fluorescence spectrometry after borate fusion at NIST [4] and the collaborating laboratory
ICP-OES	Inductively coupled plasma optical emission spectrometry at the collaborating laboratory
Gravimetry	Indicates the specific gravimetric method found in ASTM C 114-15 performed by the collaborating laboratory
UV absorbance	The colorimetric method found in ASTM C 114-07 performed by the collaborating laboratory.

[b] Borate fusion was not used at NIST for Cl by the standard additions calibration.

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