

## Reference Material Certificate: Pulverised Bauxite PBS-75

Table 1: PBS-75 Certified Values expressed as % w/w

| Analyte                        | Certified Value (y) | Standard Deviation (s) |                 | 95% Confidence Interval (CI) |       | $U_{CRM}^{\wedge}$ | $k^{\#}$ | $U_{CRM}^{\sim}$ | No. of Labs (ISO/IE C 17025) | No. Samples |
|--------------------------------|---------------------|------------------------|-----------------|------------------------------|-------|--------------------|----------|------------------|------------------------------|-------------|
|                                |                     | 1 SD                   | 1 SD Within Lab | lower                        | upper |                    |          |                  |                              |             |
| Al <sub>2</sub> O <sub>3</sub> | 46.76               | 0.118                  | 0.102           | 46.70                        | 46.83 | 0.083              | 2.31     | 0.192            | 8                            | 39          |
| SiO <sub>2</sub>               | 15.90               | 0.092                  | 0.062           | 15.83                        | 15.96 | 0.049              | 2.31     | 0.113            | 8                            | 40          |
| Fe <sub>2</sub> O <sub>3</sub> | 19.15               | 0.092                  | 0.058           | 19.09                        | 19.22 | 0.063              | 2.26     | 0.142            | 9                            | 44          |
| TiO <sub>2</sub>               | 2.53                | 0.022                  | 0.011           | 2.52                         | 2.55  | 0.010              | 2        | 0.020            | 10                           | 49          |
| MnO                            | 0.042               | 0.0039                 | 0.0018          | 0.039                        | 0.045 | 0.0016             | 2.26     | 0.0036           | 9                            | 45          |
| CaO                            | 0.022               | 0.0039                 | 0.0019          | 0.019                        | 0.025 | 0.0101             | 2.26     | 0.0228           | 9                            | 44          |
| P <sub>2</sub> O <sub>5</sub>  | 0.070               | 0.0022                 | 0.0010          | 0.068                        | 0.071 | 0.0017             | 2.26     | 0.0038           | 9                            | 43          |
| SO <sub>3</sub>                | 0.061               | 0.0092                 | 0.0028          | 0.049                        | 0.073 | 0.0046             | 2.57     | 0.0118           | 5                            | 25          |
| MgO                            | 0.070               | 0.0136                 | 0.0039          | 0.058                        | 0.081 | 0.0117             | 2.31     | 0.027            | 8                            | 40          |
| K <sub>2</sub> O               | 0.024               | 0.0049                 | 0.0027          | 0.020                        | 0.027 | 0.0101             | 2.31     | 0.0234           | 8                            | 40          |
| Na <sub>2</sub> O              | 0.027               | 0.0092                 | 0.0051          | 0.019                        | 0.034 | 0.0118             | 2.31     | 0.0271           | 8                            | 39          |
| Cr <sub>2</sub> O <sub>3</sub> | 0.045               | 0.0044                 | 0.0035          | 0.042                        | 0.048 | 0.0023             | 2.31     | 0.0053           | 8                            | 40          |
| V <sub>2</sub> O <sub>5</sub>  | 0.060               | 0.0010                 | 0.0007          | 0.059                        | 0.061 | 0.0016             | 2.36     | 0.0037           | 7                            | 33          |
| ZrO <sub>2</sub>               | 0.122               | 0.0083                 | 0.0034          | 0.113                        | 0.130 | 0.0035             | 2.45     | 0.0087           | 6                            | 30          |
| LOI1000                        | 15.22               | 0.082                  | 0.061           | 15.16                        | 15.27 | 0.037              | 2.36     | 0.089            | 7                            | 35          |

Note 1. SI units equivalent: 1 ppm, parts per million  $\equiv$  grams per ton  $\equiv$  mg/kg  $\equiv$  ug/g  $\equiv$  0.0001 wt.%  $\equiv$  100ppb, parts per billion

Note 2. The number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD.

$\wedge$  Standard uncertainty.

$\#$  Coverage Factor.

$\sim$  Expanded Uncertainty.

Table 2: PBS-75 Informational Values

| Analyte                        | Certified Value (y) | No. of Labs (ISO/IEC 17025) | No. Samples |
|--------------------------------|---------------------|-----------------------------|-------------|
| Ba                             | 0.013               | 1                           | 5           |
| Ga <sub>2</sub> O <sub>3</sub> | 0.027               | 1 (non-17025 lab)           | 5           |
| NiO                            | 0.008               | 1                           | 5           |
| Sr                             | 0.008               | 1                           | 5           |
| Zn                             | 0.001               | 1                           | 3           |

## Version History

| Batch | Author    | Document Version | Date       | Modifications    |
|-------|-----------|------------------|------------|------------------|
| PBS75 | Harry Ooi | R0               | 10/08/2022 | Initial Document |

## Introduction

This document specifies preparation, analysis, and certification of pulverised reference material.

## Material and Method of Preparation

PBS-75 is manufactured from a pulverised bauxite material. The material underwent a multi-stage crushing, pulverisation and screening prior to homogenisation process and discharge into storage containers. During the discharge the material was sub-sampled at regular intervals from which homogeneity and characterisation samples were drawn.

The samples taken were randomised before being submitted to independent ISO/IEC 17025 accredited laboratories for homogeneity and inter-laboratory round-robin testing.

## Homogeneity Analysis

A homogeneity study was undertaken in accordance with ISO Guide 35:2017 and ISO17034:2016 using systematically selected samples to be representative of the entire batch. The sample identifiers were randomised to ensure different production order and laboratory analytical order. These samples were submitted to a single laboratory for multiple analysis in a single batch under repeatable conditions. The homogeneity study results were reviewed to ensure all analytes were deemed homogeneous prior to the material progressing to the inter-laboratory round-robin stage for characterisation assessment. A summary of the study is presented in Table 3 with results summarised in Table 4.

*Table 3: Homogeneity Study Parameters*

| Attribute                     | Value |
|-------------------------------|-------|
| Sample mass /unit             | 10g   |
| No. samples submitted         | 23    |
| No. determinations per sample | 2     |

Table 4: Homogeneity Study Results

| Analyte                        | Avg. Concentration Homogeneity Lab (% w/w) | SD between samples median value | Relative SD % |
|--------------------------------|--|---------------------------------|---------------|
| Al <sub>2</sub> O <sub>3</sub> | 46.63                                      | 0.057                           | 0.1           |
| SiO <sub>2</sub>               | 15.80                                      | 0.030                           | 0.2           |
| Fe <sub>2</sub> O <sub>3</sub> | 19.16                                      | 0.041                           | 0.2           |
| TiO <sub>2</sub>               | 2.56                                       | 0.0056                          | 0.2           |
| MnO                            | 0.042                                      | 0                               | 0             |
| CaO                            | 0.020                                      | 0                               | 0             |
| P <sub>2</sub> O <sub>5</sub>  | 0.068                                      | 0.0009                          | 1.3           |
| SO <sub>3</sub>                | 0.072                                      | 0.0009                          | 1.2           |
| MgO                            | 0.049                                      | 0.0029                          | 5.9           |
| K <sub>2</sub> O               | 0.029                                      | 0.0004                          | 1.4           |
| Na <sub>2</sub> O              | 0.012                                      | 0.0033                          | 27            |
| As                             | 0.001                                      | 0.0002                          | 16            |
| Ba                             | 0.010                                      | 0                               | 0             |
| Ga                             | 0.005                                      | 0                               | 0             |
| Cr <sub>2</sub> O <sub>3</sub> | 0.045                                      | 0.0013                          | 2.9           |
| NiO                            | 0.005                                      | 0.0010                          | 21            |
| Pb                             | 0.002                                      | 0.0006                          | 36            |
| Sr                             | 0.005                                      | 0.0007                          | 14            |
| V <sub>2</sub> O <sub>5</sub>  | 0.057                                      | 0.0007                          | 1.2           |
| Zn                             | 0.001                                      | 0                               | 0             |
| ZrO <sub>2</sub>               | 0.122                                      | 0                               | 0             |
| LOI                            | 15.26                                      | 0.022                           | 0.1           |

## Material Characterisation and Certification Methodology

A total of 50 x 10g samples were randomly selected for inter-laboratory round-robin analysis, 5 samples were provided to 10 ISO17025 accredited laboratories. Laboratories analysed samples via Fusion XRF & TGA. 10 laboratories returned results in this round.

The process of characterisation was undertaken in accordance with ISO Guide 35:2017 and ISO17034:2016 following examination of grouped laboratory results for potential technical failures by way of comparison with the established CRM submitted for analysis with the candidate material. Where required, further investigation of outliers was conducted. Laboratory results deemed technical outliers were removed from the analysis pool prior to the determination of statistical parameters. The certifying officer, in some cases, may use their judgment in identifying or eliminating outliers outside of these statistical parameters.

- Certified value was determined by average of lab averages for analytes with no outlier laboratory results, or median of median for those with outlier laboratory results.
- Standard deviation ( $s$ ) is the measure of spread of analyte determinations and includes inter-laboratory bias, method uncertainty, and material homogeneity uncertainty. Approximately 95% of determinations using the same analytical method are expected to be between two standard deviations either side of the certified value. The standard deviation is calculated from the validated laboratory group data less outlier laboratory and individual determinations.
- Confidence Interval ( $CI$ ) is an estimate of the true (unknowable) analyte concentration in the material at the 95% confidence interval. For example, a 95%  $CI$  could be interpreted as there is a 0.95 probability that the true value is between certified value  $\pm CI$ . The narrower the interval, the more precise the certified value. The 95%  $CI$  should not be used for determination of quality control gates.
- Standard Uncertainty ( $u_{CRM}$ ) is the sum of variance from characterisation, homogeneity and stability studies. The uncertainty of characterisation is derived from the standard deviation of average of laboratory averages divided by the square root of the number of laboratories. Uncertainty of material homogeneity ( $u_{hom}$ ) is the sum of ANOVA within and between sample uncertainty derived from the homogeneity study. An allowance for stability has been included in accordance with ISO Guide 35.
- Coverage Factor ( $k$ ) is the students t-distribution value for two tailed test at 95%.
- Expanded Uncertainty ( $U_{CRM}$ ) is the product of coverage factor and standard uncertainty, and represents the 95% confidence interval of the true unknowable analyte concentration of the batch combined with the bias from individual samples.

The certified value of any analyte may not be less than 0.00 % even though in some cases the uncertainty error bounds define a range outside of 0.00 %. These cases are due to low concentrations of some analytes relative to the analytical detection limits and increments of precision

## Participating Laboratories

Laboratories used in the certification process are listed in Table 5 in alphabetical order, along with batch number.

Table 5: PBS-75 Participating Laboratories

| Laboratory Name               | Location                 | Job #          |
|-------------------------------|--------------------------|----------------|
| Activation Laboratory         | Ontario, Canada          | A22-08685      |
| ALS Brisbane                  | Queensland, Australia    | BR22171735     |
| ALS Loughrea                  | Loughrea, Ireland        | LR22167448     |
| ALS Malaga                    | Western Australia        | PH22159710     |
| ALS Vancouver                 | Vancouver, Canada        | VA22169276     |
| BV Canning Vale               | Western Australia        | u326541        |
| Intertek Genalysis Maddington | Western Australia        | 1771_0_2213289 |
| PT Intertek Utama Services    | Jakarta, Indonesia       | 222272         |
| SGS Burnaby                   | British Columbia, Canada | BBM22-18844    |
| SGS Lakefield                 | Ontario, Canada          | CA02298-JUL22  |
| SGS Newburn                   | Western Australia        | WM212130       |

## Intended Use

This bauxite reference material is intended for routine quality control (QC) monitoring of the accuracy and precision of XRF/TGA analysis. Crushed bauxite reference materials are used to determine the laboratory's ability to prepare, sub-sample and analyse. The combination of crushed and pulverised bauxite reference materials when inserted into runs of test samples is recommended as part of QC monitoring.

The estimate of material and measurement uncertainties reported in this certificate are the product of the participating laboratories, not any individual laboratory. Commercial laboratories typically have different measurement uncertainties to site-based laboratories. Application of the grouped uncertainties reported in this certificate to a specific laboratory for ongoing QC may lead to many false reports of out-of-control processes, or alternatively non reporting of out-of-control processes.

It is recommended that the centre line and control limits of a Shewhart chart used for ongoing monitoring of a particular laboratory are derived from averaged values and variation from replicate analysis of this CRM after removal of outliers.

## Preparer and supplier of reference material

The bauxite reference material PBS-75 has been prepared and certified by:

Independent Mineral Standards Pty Ltd  
16-18 Durham Rd  
Bayswater, WA 6053  
Australia

[www.imstandards.com.au](http://www.imstandards.com.au)

The material has been supplied in 10g heat sealed aluminised plastic bags and also 1kg press-seal plastic jars with unique labels showing batch number and sample number.

## Minimum Sample Mass

This reference material has been certified using 0.2g to 0.5g aliquots for Li-B fusion XRF analysis. Uncertainty and homogeneity statements relating to this are only applicable if a minimum of 0.2g sample mass is used during Li-B fusion XRF analysis.

## Period of Validity

This Certificate is valid 10 years from the date of original issue.

## Commutability

This pulverised reference material is not commutable to any other analytical methods than as stated by its intended use.

## Metrological Traceability

Metrological traceability of the assigned values and their uncertainties has been established through an unbroken chain to the SI unit kilogram. This is achieved through the use of accredited ISO17025 assay laboratories during homogeneity, characterisation and stability studies.

## Stability and Storage Instructions

This CRM is an oxidised reference material and is stable in the sealed aluminised plastic bags, or press-sealed plastic jars under normal conditions of storage. It is recommended to keep jars sealed at all times when not in use.

## Instructions for Correct Use

The recommended values for this CRM refer to the concentration levels after removal of hygroscopic moisture by drying in air to constant mass at 105°C. If the reference material is not dried prior to analysis, the recommended value should be corrected to the moisture bearing basis.

## Legal notice

Independent Mineral Standards Pty Ltd has prepared and statistically evaluated the property values of this reference material to the best of ability. The purchaser by receipt hereof releases and indemnifies Independent Mineral Standards Pty Ltd from and against all liability and costs from the use of this material and information.

## Certifying officer

Bruce Armstrong

## Certification date

10<sup>th</sup> August 2022.

## References

ISO Guide 35:2017, Reference materials – General and statistical principles for certification.

ISO17034:2016, General Requirements for the competence of reference material producers.