

ASH CONSTITUENTS' PROFICIENCY TESTING

REPORT SIXTY-THREE

Revision: 00

Final report

31 JANUARY 2023

LABORATORY CODE: b



R BABOOLAL (SCHEME MANAGER)

THINKING QUALITY, QUALITY THINKING

EXECUTIVE SUMMARY

1. Thirteen samples were sent to participants with 10 results reported back.
2. The total number of outliers found were as follows:
 - SiO₂ x1
 - MgOx1
 - Na₂O x1
 - SO₃ x1
3. Robust statistics were applied where ten or more results were available.
4. Use the z-score trend as an indication of the overall laboratory performance.

TABLE OF CONTENTS

ITEM	PAGE NUMBER
Letter to participant	5
List of participants	6
Type of sample used	7
Preparation of sample	7
Homogeneity check	7
Silicon Oxide results and trend	8
Aluminium oxide results and trend	9
Potassium oxide results and trend	10
Magnesium oxide results and trend	11
Calcium oxide results and trend	12
Manganese oxide results and trend	13
Iron oxide results and trend	14
Sodium oxide results and trend	15
Titanium oxide results and trend	16
Sulphur tri-oxide results and trend	17
Phosphorous pent-oxide results and trend	18
Conclusion	19
Terms and Conditions	20

Dear Participant

RE: PROFICIENCY TESTING RESULTS FOR THE MONTH OF JANUARY 2023

Thank you for your participation in the Coal Concepts Ash constituent's proficiency testing scheme.

Your laboratory code is as per the cover page.

All results are totally confidential. Any results in ***bold, italics, underlined*** are outliers. Where applicable, the most extreme outliers have been eliminated from calculation of averages using the Grubbs estimate for outliers.

Please take note of the following:

1. Z-scores between -1 and +1 is deemed acceptable
2. Z-scores between -2 and -3 should serve as a warning that the analysis result could get worse
3. Z-scores between +2 and +3 should also serve as a warning that analysis results could get worse.
4. Z- scores lower than -3 and exceeding +3 should warrant an investigation
6. All calculations can be made available upon request

The Coal Concepts scheme adheres to the requirements of ISO/IEC 17043:2010 – Conformity assessment – General requirements for proficiency testing.

Statistical analysis has been carried out using ISO/IEC 13528:2015-Statistical methods for use in proficiency testing by interlaboratory comparisons.

Please find results attached together with Z-score trends.

Best Regards

R Baboolal

LIST OF PARTICIPANTS IN ALPHABETICAL ORDER

AfriSam (South Africa) (Pty) Ltd - Dudfield
AfriSam (South Africa) (Pty) Ltd - Ulco
Alfred H Knight Richards Bay Lab
Bureau Veritas Inspectorate Laboratories Alton
Laboratory for solid fuels-Mining Institute Belgrade
Morupule Coal Mine - Botswana
Rio Tinto –Richards Bay
Ronewa Middelburg
SABS Commercial SOC - CSIR Laboratory
SABS Commercial SOC - Richards Bay Laboratory
Sibonisiwe Coal Laboratory Services
Siza Coal Services - Middelburg
Siza Minerals Lab - Palapye
South 32 -Hotazel Manganese Mines
UIS Analytical Services
Vinca Institute of Nuclear Sciences – Serbia

1. TYPE OF SAMPLE USED

The ash used in this proficiency testing round was obtained from local thermal coal

2. PREPARATION OF SAMPLE

About 5kgs coal was pulverised to -212µm. The coal was ashed in a furnace according to the ISO ashing programme. The bulk sample was transferred to a 5-litre container. The sample was homogenised by shaking the 5-litre container vigorously, for half an hour. Samples from the 5-litre container were then transferred into 100ml plastic bottles. Each sample weighed approximately 10 grams. Two hundred and seventy bottles of sample were weighed out. Five bottles were randomly selected and tested for homogeneity SO₃ as the analysed.

3. HOMOGENEITY CHECK

SAMPLE NO.	TEST PORTION 1	TEST PORTION 2	sample av (Xt)	range (Wt)	range sqd
1	2,32	2,43	2,38	0,11	0,0121
2	2,40	2,44	2,42	0,04	0,0016
3	2,47	2,43	2,45	0,04	0,0016
4	2,35	2,36	2,36	0,01	0,0001
5	2,54	2,59	2,57	0,05	0,0025
GENERAL AVERAGE			2,43		
STANDARD DEVIATION			0,083		
WITHIN SAMPLE STANDARD DEVIATION			0,042		
BETWEEN SAMPLE STANDARD DEVIATION			0,077		

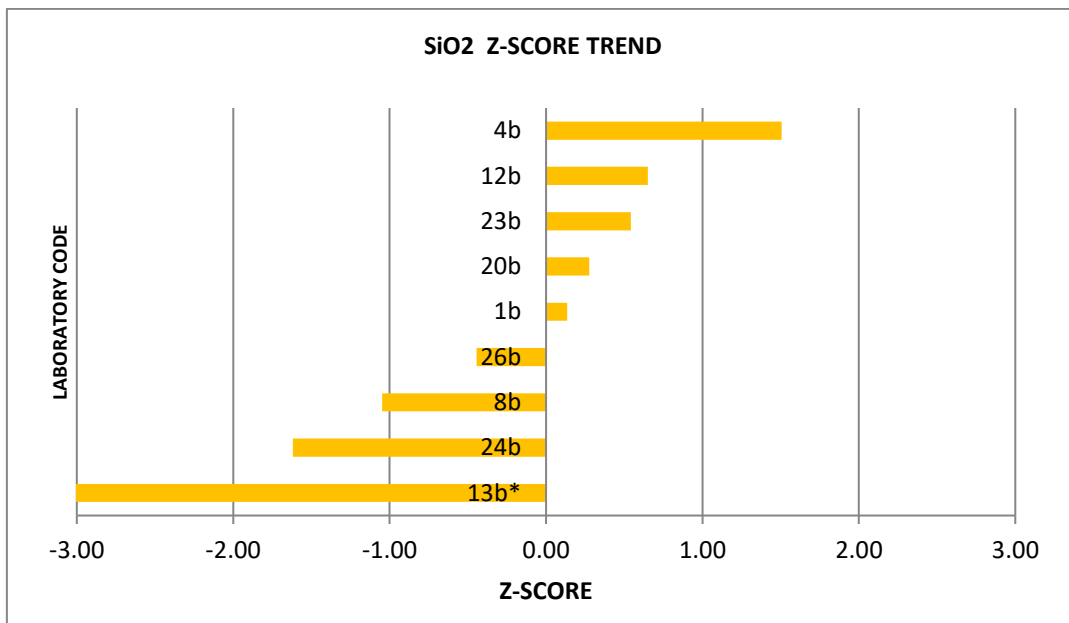
The between sample standard deviation must be $\leq 0.3 \times \sigma$
 (σ = std deviation for the proficiency assessment)

$\sigma = 0.103$ was used (repeatability for SO₃)

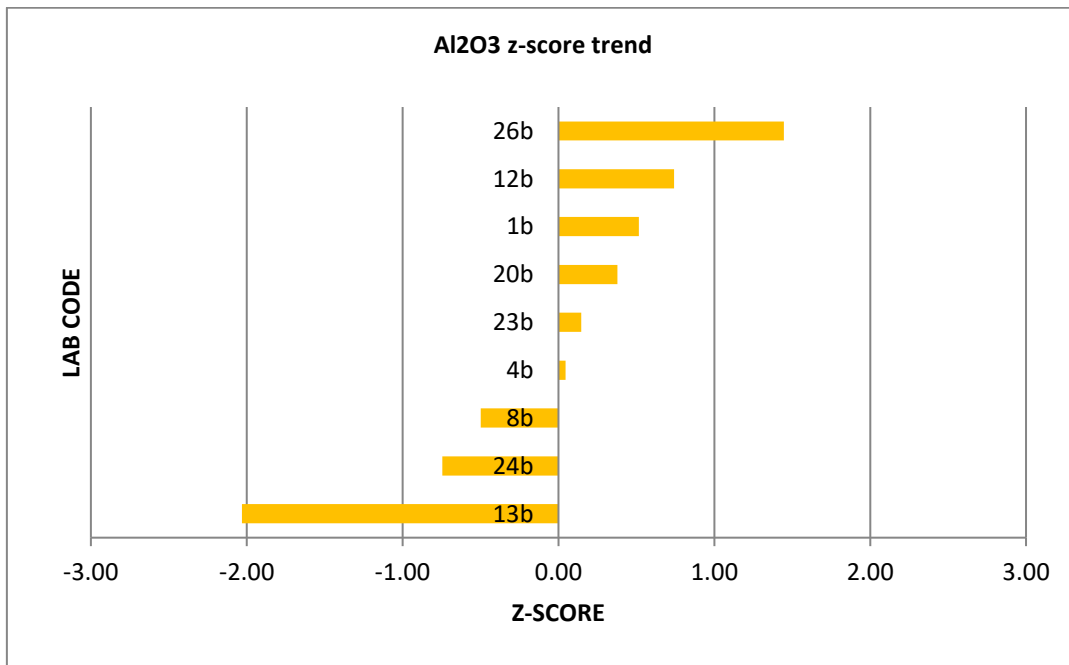
Hence $0.3 \times 0.103 = 0.031$

Since 0.007 < 0.031 the samples are homogenous

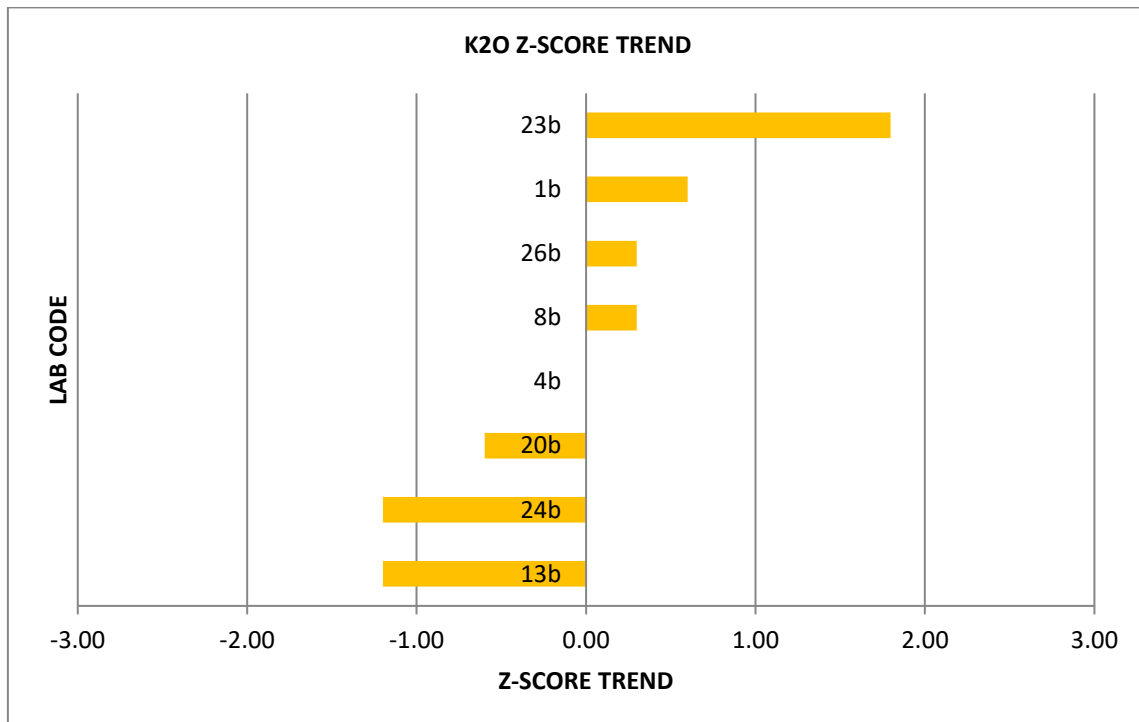
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: SiO ₂ (%)			
	LAB ID	SiO ₂ %	Z-SCORE
	1b	52,65	0,13
	4b	54,67	1,51
	8b	50,91	-1,05
	12b	53,41	0,65
	<u>13b*</u>	<u>44,00</u>	<u>-5,74</u>
	20b	52,86	0,28
	23b	53,25	0,54
	24b	50,07	-1,62
	26b	51,80	-0,44
Number of results	-	9	-
OUTLIERS	-	1	-
AVERAGE	-	52,45	-
MEDIAN	-	52,76	-
STD DEVIATION	-	1,47	-
ROBUST AVERAGE	-	-	-
ROBUST STD DEV	-	-	-
U,O,M	-	-	-



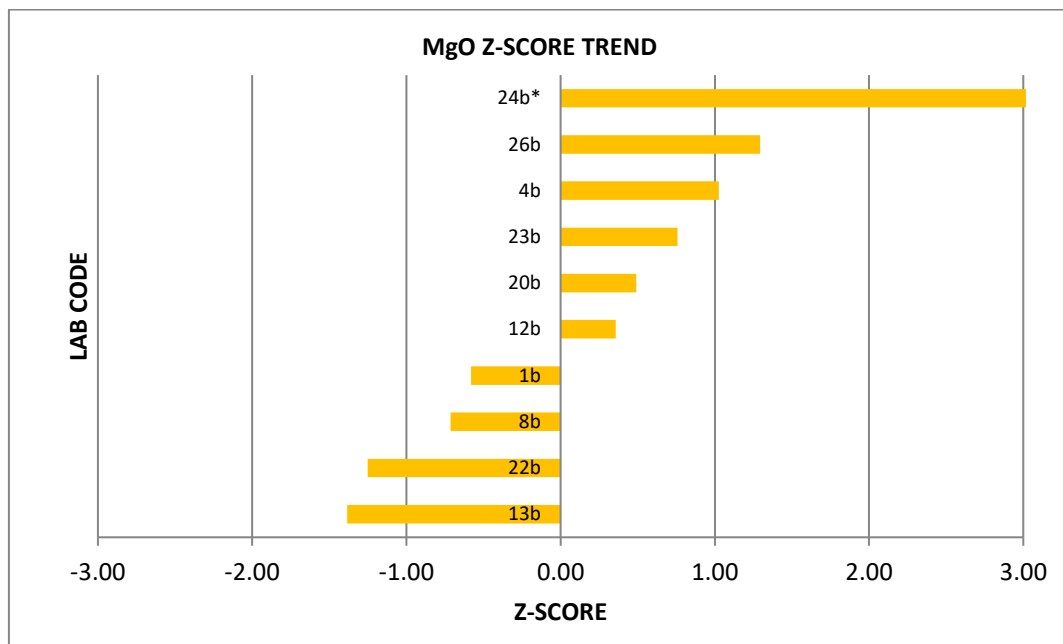
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: Al2O3 (%)			
	LAB ID	Al2O3 %	Z-SCORE
	1b	32,73	0,52
	4b	32,08	0,05
	8b	31,33	-0,50
	12b	33,04	0,74
	13b	29,22	-2,03
	20b	32,54	0,38
	23b	32,22	0,15
	24b	30,99	-0,75
	26b	34,01	1,45
Number of results	-	9	-
OUTLIERS	-	0	-
AVERAGE	-	32,02	-
MEDIAN	-	32,22	-
STD DEVIATION	-	1,38	-
ROBUST AVERAGE	-	-	-
ROBUST STD DEV	-	-	-
U.O.M	-	-	-



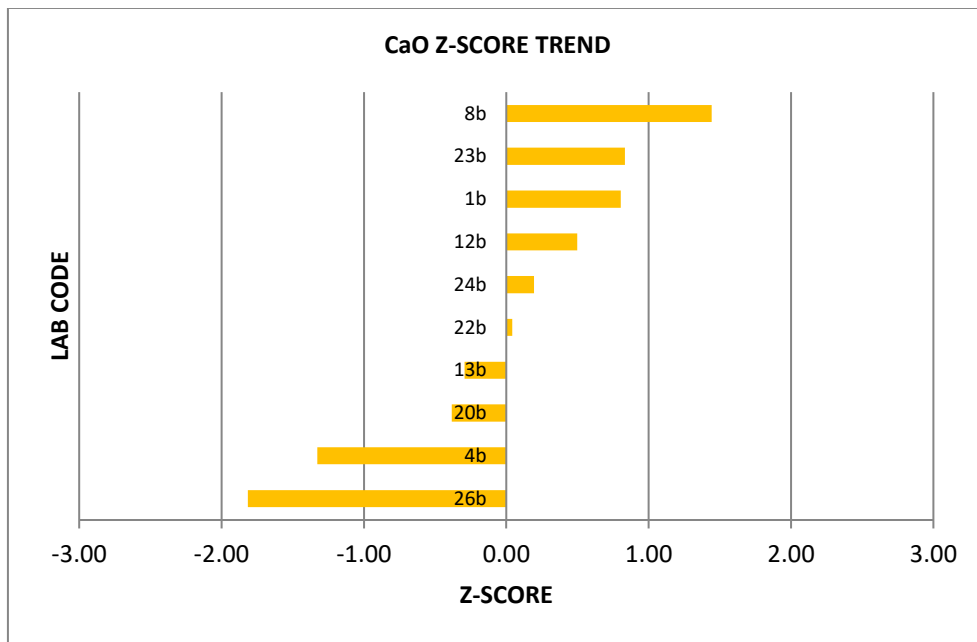
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: K2O (%)			
	LAB ID	K2O %	Z-SCORE
	1b	0,66	0,60
	4b	0,64	0,00
	8b	0,65	0,30
	13b	0,60	-1,20
	20b	0,62	-0,60
	23b	0,70	1,80
	24b	0,60	-1,20
	26b	0,65	0,30
Number of results	-	8	-
OUTLIERS	-	0	-
AVERAGE	-	0,64	-
MEDIAN	-	0,65	-
STD DEVIATION	-	0,03	-
ROBUST AVERAGE	-	-	-
ROBUST STD DEV	-	-	-
U,O,M	-	-	-



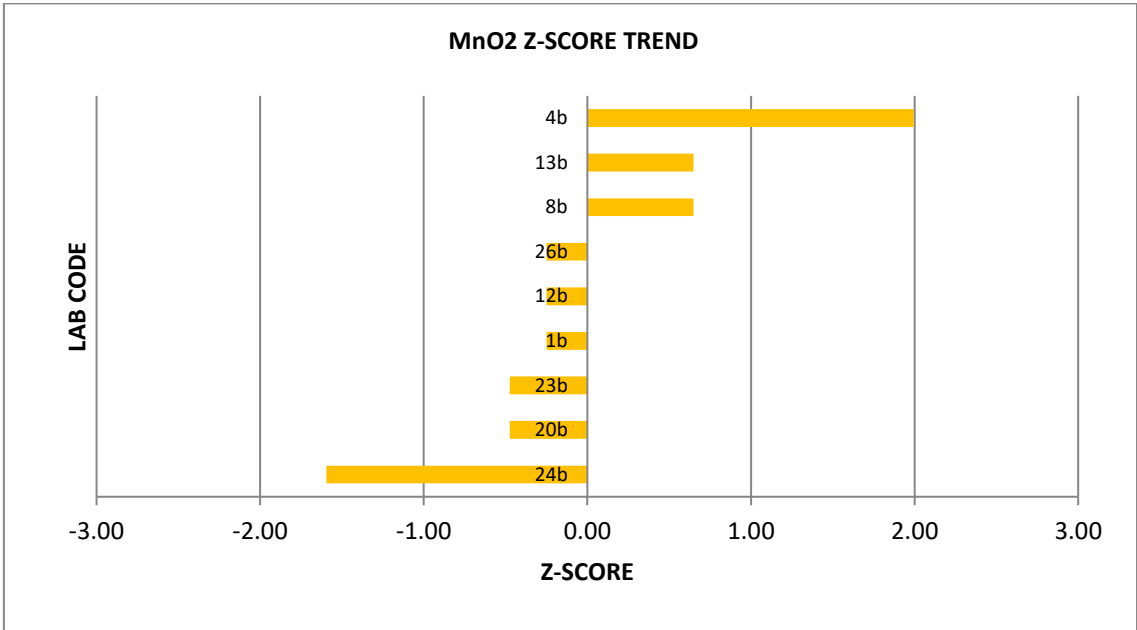
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: MgO (%)			
	LAB ID	MgO %	Z-SCORE
	1b	0,95	-0,58
	4b	1,07	1,03
	8b	0,94	-0,71
	12b	1,02	0,36
	13b	0,89	-1,38
	20b	1,03	0,49
	22b	0,90	-1,25
	23b	1,05	0,76
	24b*	1,30	4,11
	26b	1,09	1,29
Number of results	-	10	-
OUTLIERS	-	1	-
AVERAGE	-	0,99	-
MEDIAN	-	1,02	-
STD DEVIATION	-	0,07	-
ROBUST AVERAGE	-	-	-
ROBUST STD DEV	-	-	-
U,O,M	-	-	-



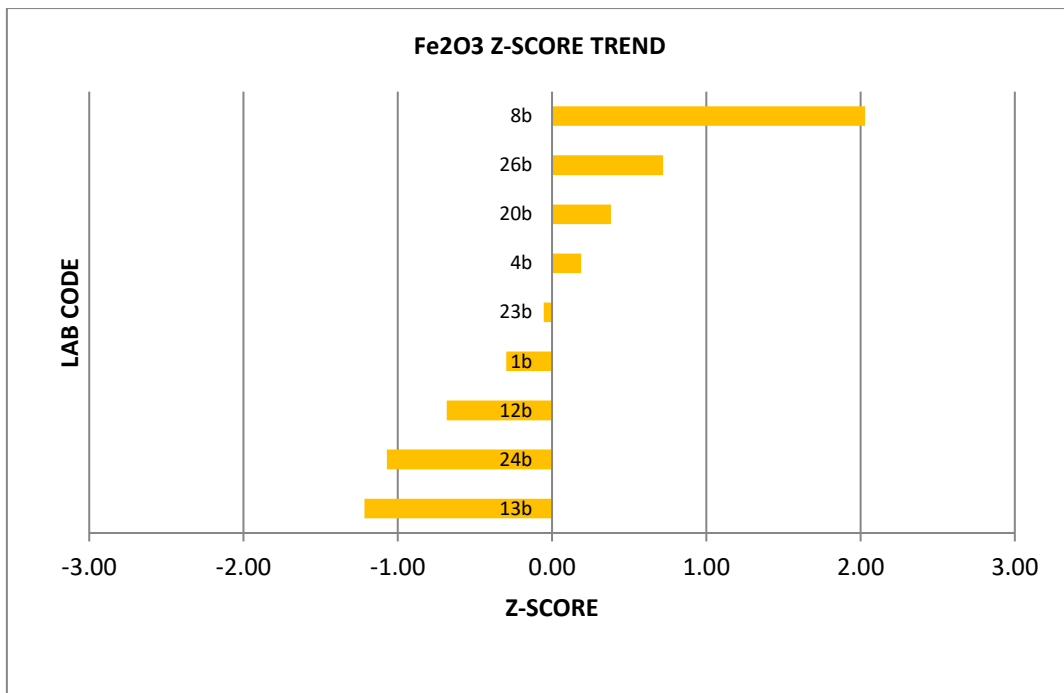
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: CaO (%)			
	LAB ID	CaO %	Z-SCORE
	1b	4,06	0,80
	4b	3,36	-1,33
	8b	4,27	1,44
	12b	3,96	0,50
	13b	3,70	-0,29
	20b	3,67	-0,38
	22b	3,81	0,04
	23b	4,07	0,83
	24b	3,86	0,19
	26b	3,20	-1,81
Number of results	-	10	-
OUTLIERS	-	0	-
AVERAGE	-	3,80	-
MEDIAN	-	3,84	-
STD DEVIATION	-	0,33	-
ROBUST AVERAGE	-	3,81	-
ROBUST STD DEV	-	0,39	-
U.O.M	-	0,16	-



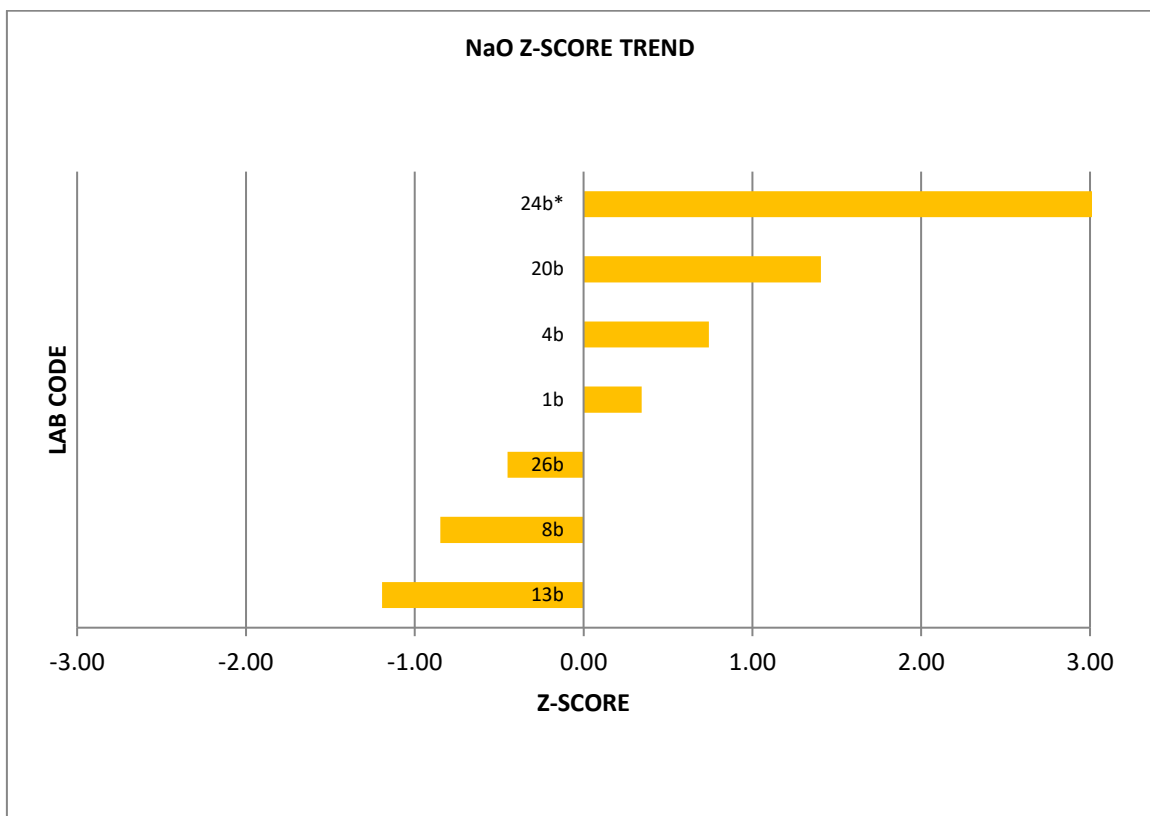
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: MnO2 (%)			
	LAB ID	MnO2 %	Z-SCORE
	1b	0,042	-0,25
	4b	0,062	1,99
	8b	0,050	0,65
	12b	0,042	-0,25
	13b	0,050	0,65
	20b	0,040	-0,47
	23b	0,040	-0,47
	24b	0,030	-1,60
	26b	0,042	-0,25
Number of results	-	9	-
OUTLIERS	-	0	-
AVERAGE	-	0,044	-
MEDIAN	-	0,042	-
STD DEVIATION	-	0,009	-
ROBUST AVERAGE	-	-	-
ROBUST STD DEV	-	-	-
U,O,M	-	-	-



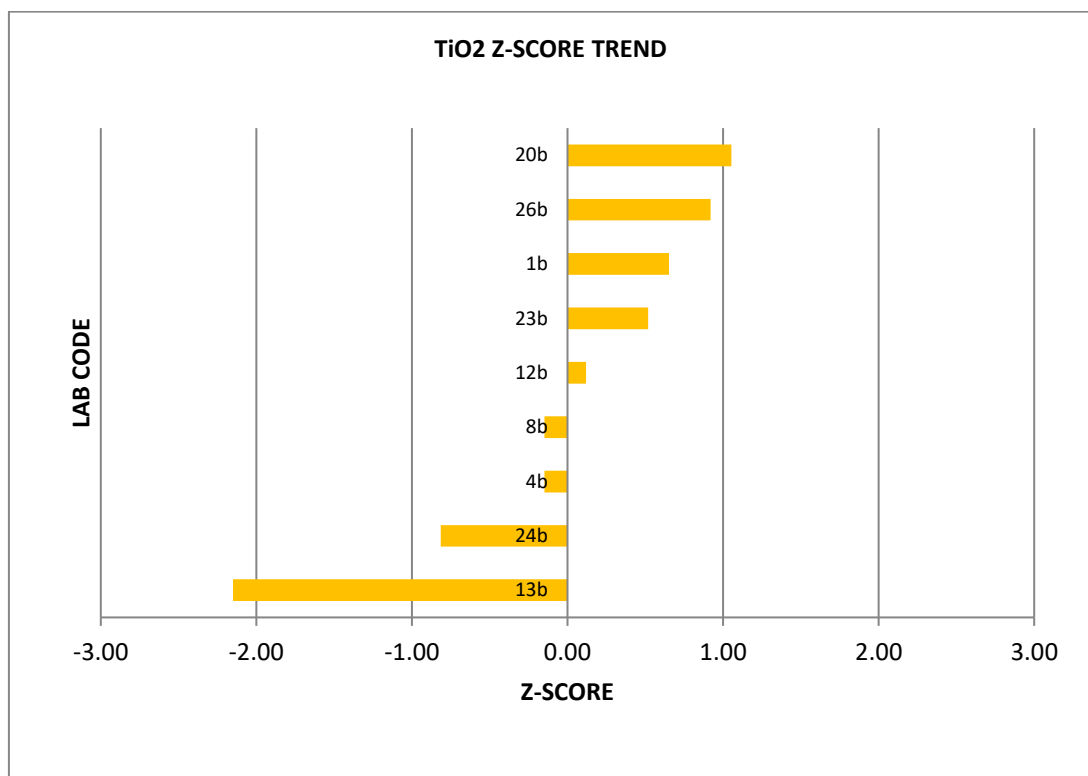
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: Fe2O3 (%)			
	LAB ID	Fe2O3 %	Z-SCORE
	1b	3,19	-0,30
	4b	3,29	0,19
	8b	3,67	2,03
	12b	3,11	-0,68
	13b	3,00	-1,22
	20b	3,33	0,38
	23b	3,24	-0,05
	24b	3,03	-1,07
	26b	3,40	0,72
Number of results	-	9	-
OUTLIERS	-	0	-
AVERAGE	-	3,25	-
MEDIAN	-	3,24	-
STD DEVIATION	-	0,21	-
ROBUST AVERAGE	-	-	-
ROBUST STD DEV	-	-	-
U.O.M	-	-	-



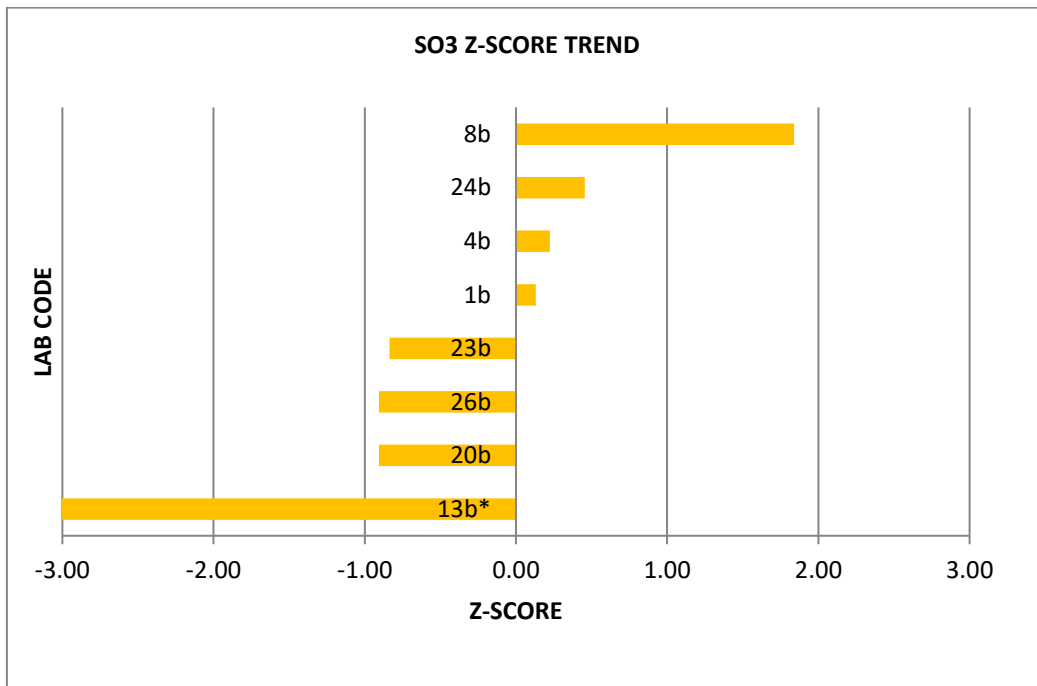
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: Na ₂ O (%)			
	LAB ID	Na ₂ O %	Z-SCORE
	1b	0,12	0,34
	4b	0,15	0,74
	8b	0,03	-0,85
	13b	0,004	-1,19
	20b	0,20	1,41
	24b*	0,59	6,58
	26b	0,06	-0,45
Number of results	-	7	-
OUTLIERS	-	1	-
AVERAGE	-	0,09	-
MEDIAN	-	0,09	-
STD DEVIATION	-	0,08	-



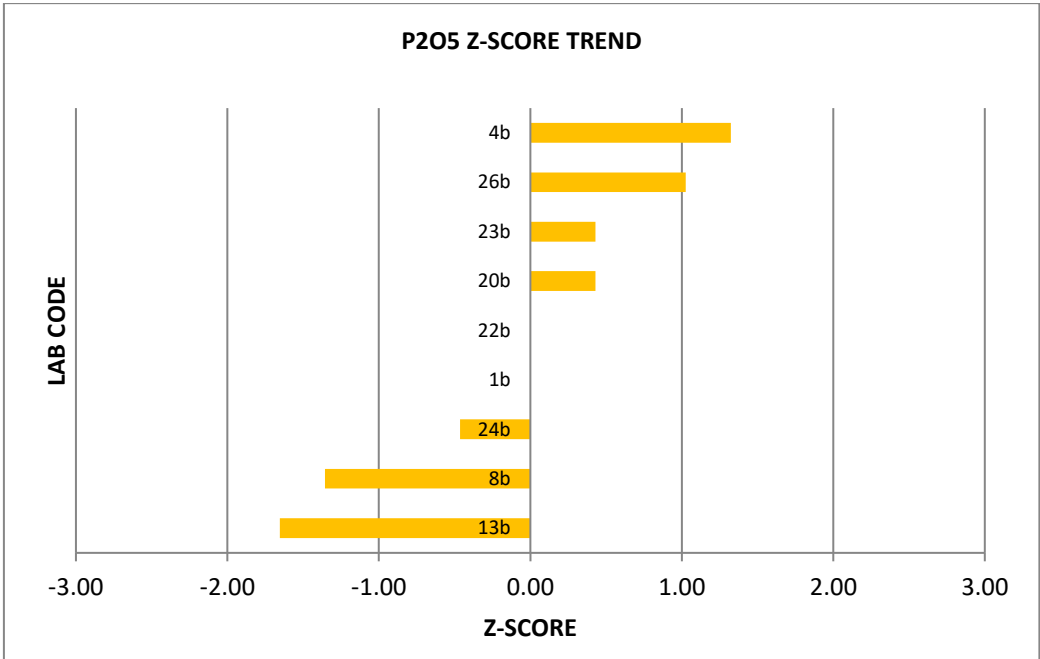
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: TiO ₂ (%)			
	LAB ID	TiO ₂ %	Z-SCORE
	1b	1,78	0,65
	4b	1,72	-0,15
	8b	1,72	-0,15
	12b	1,74	0,12
	13b	1,57	-2,15
	20b	1,81	1,05
	23b	1,77	0,52
	24b	1,67	-0,82
	26b	1,80	0,92
Number of results	-	9	-
OUTLIERS	-	0	-
AVERAGE	-	1,73	-
MEDIAN	-	1,74	-
STD DEVIATION	-	0,07	-
ROBUST AVERAGE	-	-	-
ROBUST STD DEV	-	-	-
U.O.M	-	-	-



COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: SO3 (%)			
	LAB ID	SO3 %	Z-SCORE
	1b	2,65	0,13
	4b	2,69	0,22
	8b	3,39	1,84
	13b*	0,00	-5,98
	20b	2,20	-0,91
	23b	2,23	-0,84
	24b	2,79	0,45
	26b	2,20	-0,91
Number of results	-	8	-
OUTLIERS	-	1	-
AVERAGE	-	2,59	-
MEDIAN	-	2,65	-
STD DEVIATION	-	0,43	-



COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2023			
ANALYTICAL PARAMETER: P2O5 (%)			
	LAB ID	P2O5 %	Z-SCORE
	1b	0,49	0,00
	4b	0,53	1,32
	8b	0,44	-1,36
	13b	0,43	-1,65
	20b	0,50	0,43
	22b	0,49	0,00
	23b	0,50	0,43
	24b	0,47	-0,46
	26b	0,52	1,03
Number of results	-	9	-
OUTLIERS	-	0	-
AVERAGE	-	0,49	-
MEDIAN	-	0,49	-
STD DEVIATION	-	0,03	-
ROBUST AVERAGE	-	-	-
ROBUST STD DEV	-	-	-
U.O.M	-	-	-



4. CONCLUSIONS

- 4.1 SiO₂ analysis had an even z-score distribution. The average and median did not differ by much indicating a close spread of results reported.
- 4.2 Al₂O₃ had an even z-score distribution. The median and mean and differed from each other, with an acceptable standard deviation. This indicated an acceptable distribution of results received.
- 4.3 K₂O Z-Score has a positive bias z-score distribution. No outlier was detected. Results compare well.
- 4.4 MgO had one outlier. Even z-score distribution of results.
- 4.5 Even z-score trend on CaO analysis. Mean and median differed by 0.04
- 4.6 MnO₂: The median and average compared well. No outlier detected.
- 4.7 Fe₂O₃ : The z-score trending is evenly distributed. Average and Robust Average are similar.
- 4.8 Na₂O – trending was evenly spread. One outlier detected.
- 4.9 TiO₂ analysis was well done. Mean, Median compared well.
- 4.10 SO₃ : Results received were acceptable, with a standard deviation of 0.43
- 4.11 P₂O₅: Analysis generally well done with an almost even Z-Score trending. Average and median are the same.

End of report

COAL CONCEPTS: Terms and ConditionsReturn of results:

Laboratories participate in proficiency testing programs on the understanding that they will be sharing their results and information **anonymously** with other laboratories performing the same analysis. No return of results compromises the spirit of the programs, and reports will not be sent to laboratories unless they return results. Payment in full is required from all laboratories enrolling whether they return results or not.

Errors in Participant Proficiency Testing Results:

Proficiency testing reports should reflect the level of accuracy that a regular testing client would receive.

If a participant finds an error in their proficiency testing results, they may notify us in writing and change their submission **PRIOR** to the due date for return. Changes after this time will not be accepted.

Coal Concepts' reports results *as submitted* by participants.

On occasion, it seems as though participants have mixed up the samples or not processed the samples according to the instructions. Coal Concepts cannot make assumptions of this nature and change results 'to suit'. We also cannot compromise the integrity of the programs by suggesting to some participants that they should review their results prior to the due date. (This is unfair to other participants) It is the responsibility of the participants to check all aspects of the program, including sample identification, preparation, testing instructions, calculations and reporting of the results prior to results submission.

If samples are not in good condition on arrival to the participant laboratory, Coal Concepts must be notified in writing IMMEDIATELY, as often samples can be replaced in good time. Claims about samples received in bad condition will not be accepted after the report has been issued.

Late Enrolments and Late Results:

Late enrolment requests cannot always be accommodated, as sample manufacture must be scheduled well in advance to the shipping date of the program to allow all necessary quality assurance activities to be carried out.

Shipping of PT materials and evaluating test results from PTPs out of cycle with the mainstream programs is considerably time consuming and therefore costly.

In order not to disadvantage participants able to comply with time frames, Coal Concepts may charge a late fee in the following circumstances:

Requests that Coal concepts staff enters results on behalf of participants.

Requests to record results after the due date.

Requests for PTP participation that is out of cycle with the scheduled dates.

Shipping fees and Customs clearance:

Costs incurred for shipping samples and clearance of same through customs are the responsibility of the participating laboratory unless otherwise indicated.

Non-payment of fees:

Coal Concepts retains the right to withhold reports and/or test materials and services when invoices are outstanding.

Confidentiality of results:

All data and information received by Coal Concepts from its clients are considered confidential unless the client has given express permission to pass on information.

Definitions:

The dictionary definitions of "collusion" and "falsification" are as follows.

· *Collusion*: A secret agreement or cooperation for a fraudulent or deceitful purpose.

· *Falsification*: Deliberately changing something to be false. In proficiency testing terms, collusion is comparing data (and perhaps changing data) to fit in with a believed "correct" result. This is contrary to the spirit of proficiency testing programs, which are issued with the intention of providing an objective comparison of a laboratory's performance with others. Coal Concepts tries to minimise the occurrence of collusion by being aware that laboratories should be objective when they report their results and should therefore not know the intended results at the time they are reporting to us.

Answers are not provided to clients until results have been submitted.

To prevent collusion and falsification our advice to clients is:

DON'T confer with others about PT samples or results.

DO accept the fact that everyone makes errors.

DON'T average the results or opinions of every person in the laboratory before selecting the answer to be submitted. Instead, use one of the answers AS SUBMITTED to you and take advantage of the Coal Concepts internal QA services and submit all answers generated by the technicians.

DO have confidence in your own results.

Proficiency Testing (PT) is a compulsory part of laboratory accreditation, but it is also an important tool for giving you confidence in your results.

"Enhancing" your PT results with assistance from another participant cannot increase.

confidence in your laboratory's performance.

Coal concepts' testing staff are not told what the expected results are, nor what we are expecting.

We subject ALL results to analysis, even if they are different.

The staff have the right to check that the results we enter on their behalf are correctly transcribed.

Clients are always welcome to contact Coal Concepts to seek advice or information about collusion or falsification of data.

Policy for Participant Appeal of PT Performance Assessment:

If participants disagree with their performance assessment in a proficiency report, they should inform Coal Concepts in writing.

The response will include Coal Concepts interpretation of the outcome of the reassessment and an explanation of that outcome. (For example, explanation of a calculation, or the rationale for the outcome of the evaluation.)

If a mistake has been made by Coal Concepts, it will be dealt with via Coal Concepts' non-conformance system.

Liability

In no event shall a party's liability to the other party for direct damages exceed an amount equal to the value of the amount for the PT Programme, under that specific month.