

ASH CONSTITUENTS PROFICIENCY TESTING

REPORT THIRTY-THREE

Revision: 00

Final report

JANUARY 2018

SCHEME COORDINATOR: K MUNSAMY

SCHEME MANAGER: R BABOOLAL

SIGNATURE: _____

SIGNATURE: _____

EXECUTIVE SUMMARY

1. Thirteen samples were sent to participants with 12 result submissions.
2. The total number of outliers found were as follows:
 - MgO x1
 - MnO₂ x2
 - TiO₂ x 1
3. Compare your result to that of the median value instead of the average value. The median is a better indication since the data set is small with a wide range of values.
4. Robust statistics were applied to establish the robust average and robust standard deviation. Robust statistics could not be applied for Sodium due to limitation of data.
5. The reproducibility limits have been included in the report for each element. This is to provide a better indication of the results produced by each laboratory. It is not compulsory but recommended that the laboratory investigate their results which are not within the reproducibility limits, which is indicated by **.
6. Use the z-score trend as an indication of the overall laboratory performance but treat any reflected bias with caution. A positive or negative bias may be reflected due to extreme results from some participants and these may not be flagged as outliers by Grubbs estimate

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

RE: PROFICIENCY TESTING RESULTS FOR THE MONTH OF JANUARY 2018

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

Your laboratory code is

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.

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
ALS Witlab
Aqua Specto
Bureau Veritas Nacala Lab
Bureau Veritas Inspectorate Laboratories Alton
Eskom Holdings SOC -ERID
Glencore Smelter Operations of SA - Lion Smelter
Lafarge South Africa - Lichtenburg
NOKO Analytical Services
SABS Commercial SOC - CSIR Laboratory
SABS Commercial SOC - Richards Bay Laboratory
SGS - Richards Bay Port
SGS RBCT Laboratory
Siza Coal Services - Middelburg
South 32 -Hotazel Manganese Mines

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. Fifty bottles of sample were weighed out. Ten bottles were randomly selected and tested for homogeneity SO₃ as the analyte.

3. HOMOGENEITY CHECK

SAMPLE NO.	TEST PORTION 1	TEST PORTION 2	sample av (Xt)	range (Wt)	range sqd
1	2,73	2,63	2,68	0,10	0,0100
2	2,63	2,67	2,65	0,04	0,0016
3	2,54	2,44	2,49	0,10	0,0100
4	2,63	2,75	2,69	0,12	0,0144
5	2,61	2,52	2,57	0,09	0,0081
GENERAL AVERAGE			2,62		
STANDARD DEVIATION			0,085		
WITHIN SAMPLE STANDARD DEVIATION			0,066		
BETWEEN SAMPLE STANDARD DEVIATION			0,071		

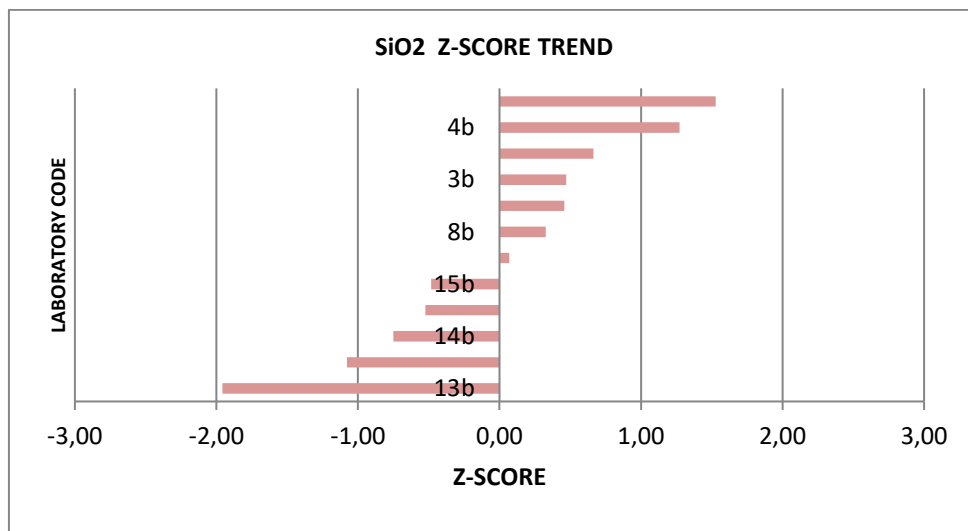
The between sample standard deviation must be $\leq 0.3 \times \sigma$
 (σ = std deviation for the proficiency assessment)

$\sigma = 0.723$ was used (repeatability for SO₃)

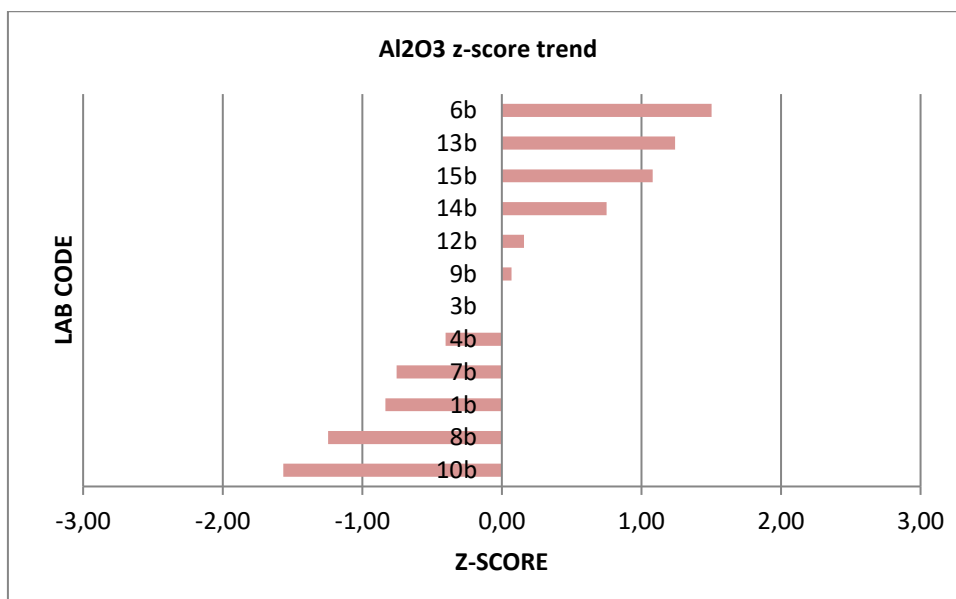
Hence $0.3 \times 0.723 = 0.217$

Since 0.071 < 0.217 the samples are homogenous

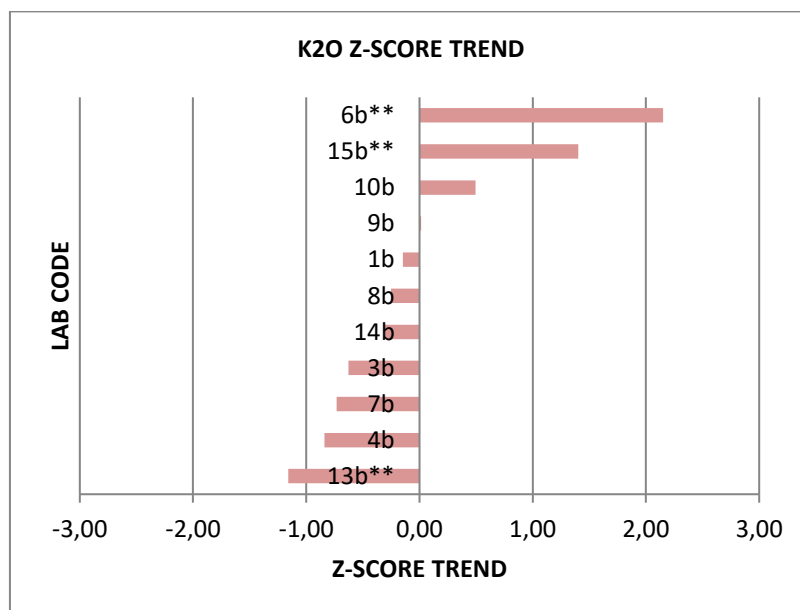
COAL CONCEPTS - PROFICIENCY TESTING -JANUARY 2018			
ANALYTICAL PARAMETER : SiO2 (%)			
	LAB ID	SiO2 %	Z-SCORE
	1b	53,21	0,66
	3b	52,83	0,47
	4b	54,42	1,27
	6b	49,75	-1,08
	7b	52,80	0,46
	8b	52,54	0,33
	9b	52,03	0,07
	10b	50,85	-0,52
	12b	54,93	1,53
	13b	48,00	-1,96
	14b	50,40	-0,75
	15b	50,93	-0,48
Number of results	-	12	12
OUTLIERS	-	0	-
AVERAGE	-	51,89	-
MEDIAN		52,29	
STD DEVIATION	-	1,99	-
ROBUST AVERAGE		51,98	
ROBUST STD DEV		2,17	
U.O.M		0,78	
REPRODUCIBILITY			
UPPER LIMIT		56,28	
LOWER LIMIT		47,50	



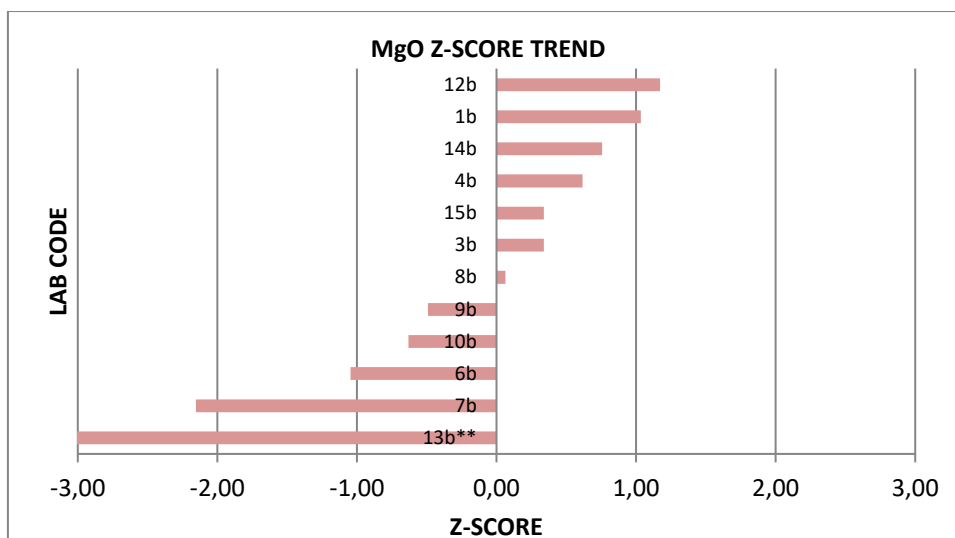
COAL CONCEPTS - PROFICIENCY TESTING -JANUARY 2018			
ANALYTICAL PARAMETER : Al₂O₃ (%)			
	LAB ID	Al₂O₃ %	Z-SCORE
	1b	30,93	-0,83
	3b	31,76	0,00
	4b	31,36	-0,40
	6b	33,26	1,50
	7b	31,01	-0,75
	8b	30,52	-1,25
	9b	31,83	0,07
	10b	30,20	-1,57
	12b	31,92	0,16
	13b	33,00	1,24
	14b	32,51	0,75
	15b	32,84	1,08
Number of results	-	12	12
OUTLIERS	-	0	-
AVERAGE	-	31,76	-
MEDIAN	-	31,80	-
STD DEVIATION	-	1,00	-
ROBUST AVERAGE		31,77	
ROBUST STD DEV		1,24	
U.O.M		0,45	
REPRODUCIBILITY			
UPPER LIMIT		35,45	
LOWER LIMIT		28,08	



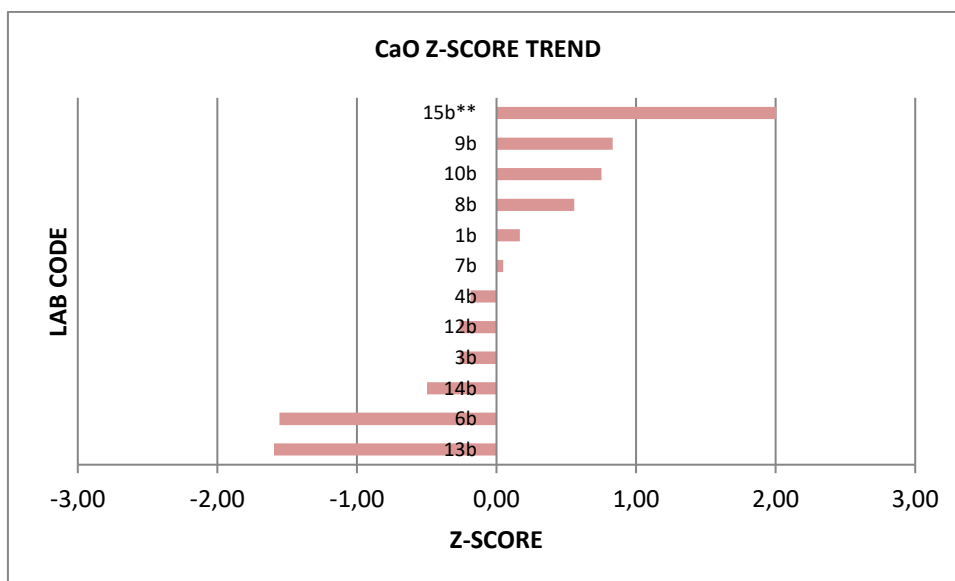
COAL CONCEPTS - PROFICIENCY TESTING -JANUARY 2018			
ANALYTICAL PARAMETER : K2O (%)			
	LAB ID	K2O %	Z-SCORE
	1b	0,87	-0,15
	3b	0,78	-0,63
	4b	0,74	-0,84
	6b**	1,30	2,15
	7b	0,76	-0,73
	8b	0,85	-0,25
	9b	0,90	0,01
	10b	0,99	0,50
	13b**	0,68	-1,16
	14b	0,84	-0,31
	15b**	1,16	1,40
Number of results	-	11	11
OUTLIERS	-	0	-
AVERAGE	-	0,90	-
MEDIAN		0,85	-
STD DEVIATION	-	0,19	-
ROBUST AVERAGE		0,88	
ROBUST STD DEV		0,20	
U.O.M		0,08	
REPRODUCIBILITY			
UPPER LIMIT		1,06	
LOWER LIMIT		0,74	



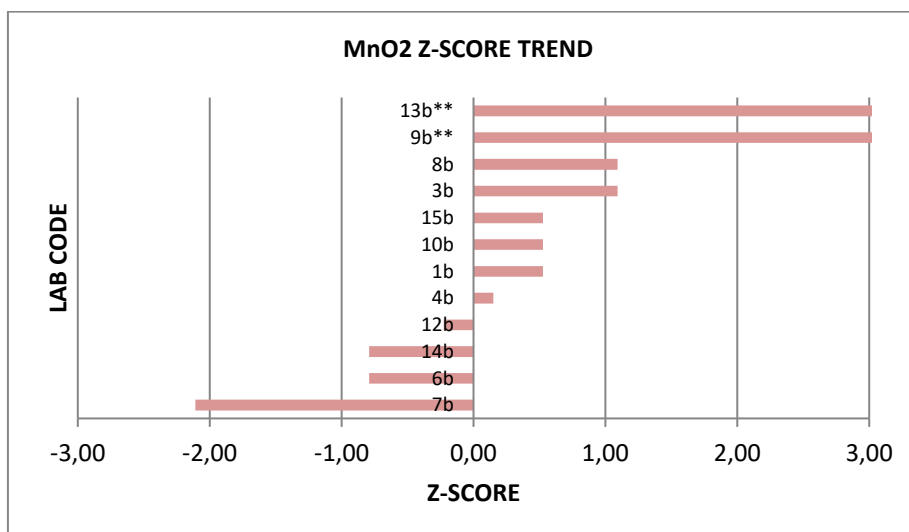
COAL CONCEPTS - PROFICIENCY TESTING -JANUARY 2018			
ANALYTICAL PARAMETER : MgO (%)			
	LAB ID	MgO %	Z-SCORE
	1b	0,58	1,03
	3b	0,53	0,34
	4b	0,55	0,62
	6b	0,43	-1,05
	7b	0,35	-2,15
	8b	0,51	0,06
	9b	0,47	-0,49
	10b	0,46	-0,63
	12b	0,59	1,17
	13b**	0,21	-4,09
	14b	0,56	0,76
	15b	0,53	0,34
Number of results	-	12	12
OUTLIERS	-	1	-
AVERAGE	-	0,51	-
MEDIAN		0,53	
STD DEVIATION	-	0,07	-
ROBUST AVERAGE		0,51	
ROBUST STD DEV		0,08	
U.O.M		0,03	
REPRODUCIBILITY			
UPPER LIMIT		0,69	
LOWER LIMIT		0,32	



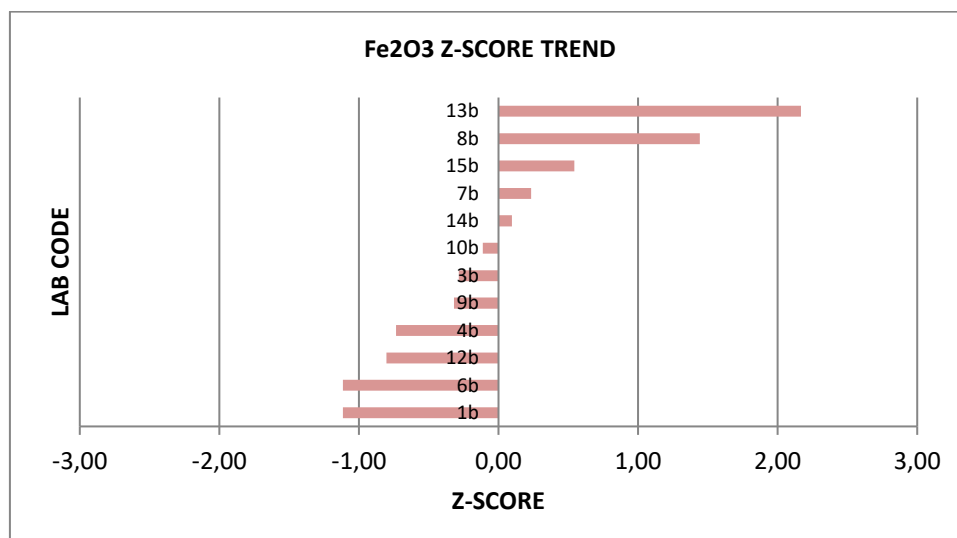
COAL CONCEPTS - PROFICIENCY TESTING -JANUARY 2018			
ANALYTICAL PARAMETER : CaO (%)			
	LAB ID	CaO %	Z-SCORE
	1b	2,64	0,17
	3b	2,53	-0,26
	4b	2,55	-0,19
	6b	2,20	-1,55
	7b	2,61	0,05
	8b	2,74	0,56
	9b	2,81	0,83
	10b	2,79	0,75
	12b	2,53	-0,26
	13b	2,19	-1,59
	14b	2,47	-0,50
	15b**	3,11	2,00
Number of results	-	12	12
OUTLIERS	-	0	-
AVERAGE	-	2,60	-
MEDIAN	-	2,58	-
STD DEVIATION	-	0,26	-
ROBUST AVERAGE		2,59	
ROBUST STD DEV		0,27	
U.O.M		0,10	
REPRODUCIBILITY			
UPPER LIMIT		3,00	
LOWER LIMIT		2,20	



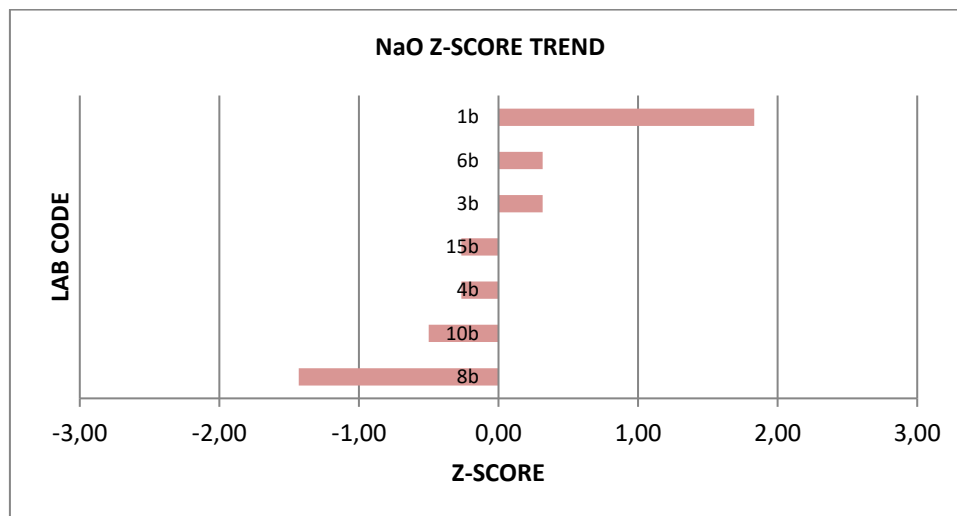
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2018			
ANALYTICAL PARAMETER : MnO2 (%)			
	LAB ID	MnO2 %	Z-SCORE
	1b	0,047	0,53
	3b	0,050	1,09
	4b	0,045	0,15
	6b	0,040	-0,79
	7b	0,033	-2,11
	8b	0,050	1,09
	<u>9b**</u>	<u>0,069</u>	<u>4,67</u>
	10b	0,047	0,53
	12b	0,043	-0,23
	<u>13b**</u>	<u>0,600</u>	<u>104,70</u>
	14b	0,040	-0,79
	15b	0,047	0,53
Number of results	-	12	12
OUTLIERS	-	2	-
AVERAGE	-	0,044	-
MEDIAN	-	0,046	-
STD DEVIATION	-	0,005	-
ROBUST AVERAGE		0,045	
ROBUST STD DEV		0,005	
U.O.M		0,002	
REPRODUCIBILITY			
UPPER LIMIT		0,066	
LOWER LIMIT		0,022	



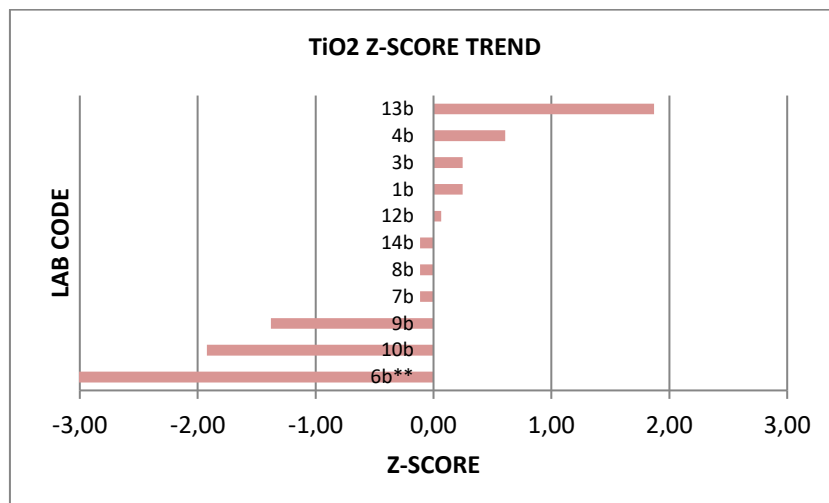
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2018			
ANALYTICAL PARAMETER : Fe2O3 (%)			
	LAB ID	Fe2O3 %	Z-SCORE
	1b	6,15	-1,11
	3b	6,39	-0,28
	4b	6,26	-0,73
	6b	6,15	-1,11
	7b	6,54	0,23
	8b	6,89	1,44
	9b	6,38	-0,32
	10b	6,44	-0,11
	12b	6,24	-0,80
	13b	7,10	2,17
	14b	6,50	0,09
	15b	6,63	0,54
Number of results	-	12	12
OUTLIERS	-	0	-
AVERAGE	-	6,47	-
MEDIAN	-	6,42	-
STD DEVIATION	-	0,29	-
ROBUST AVERAGE		6,44	
ROBUST STD DEV		0,32	
U.O.M		0,11	
REPRODUCIBILITY			
UPPER LIMIT		7,69	
LOWER LIMIT		5,26	



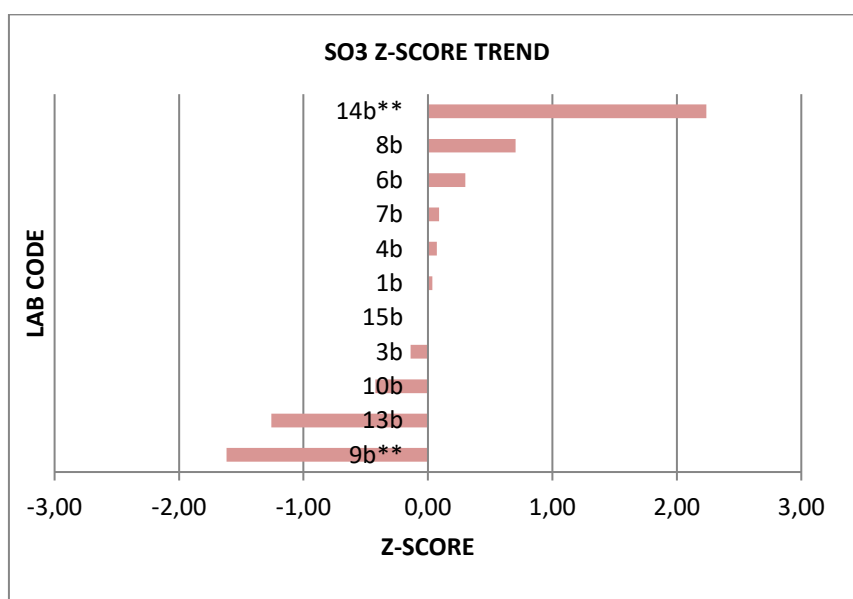
COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2018			
ANALYTICAL PARAMETER : NaO (%)			
	LAB ID	NaO %	Z-SCORE
	1b	0,10	1,83
	3b	0,07	0,32
	4b	0,06	-0,27
	6b	0,07	0,32
	8b	0,04	-1,43
	10b	0,06	-0,50
	15b	0,06	-0,27
Number of results	-	7	7
OUTLIERS	-	0	-
AVERAGE	-	0,06	-
MEDIAN		0,06	
STD DEVIATION	-	0,02	-
REPRODUCIBILITY			
UPPER LIMIT		0,48	
LOWER LIMIT		0,00	



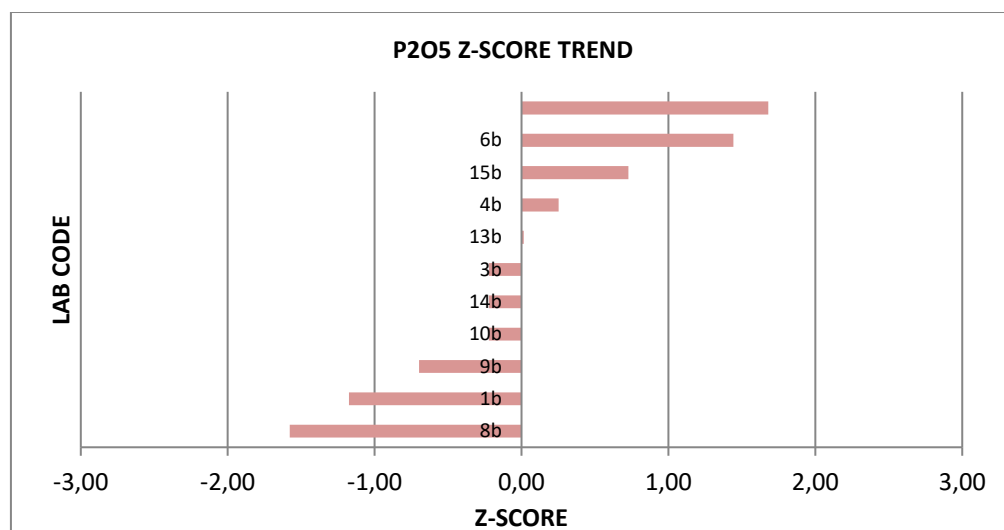
COAL CONCEPTS - PROFICIENCY TESTING -JANUARY 2018			
ANALYTICAL PARAMETER : TiO2 (%)			
	LAB ID	TiO2 %	Z-SCORE
	1b	1,88	0,25
	3b	1,88	0,25
	4b	1,90	0,61
	<u>6b**</u>	<u>1,59</u>	<u>-4,99</u>
	7b	1,86	-0,11
	8b	1,86	-0,11
	9b	1,79	-1,38
	10b	1,76	-1,92
	12b	1,87	0,07
	13b	1,97	1,87
	14b	1,86	-0,11
	15b	1,90	0,61
Number of results	-	12	12
OUTLIERS	-	1	-
AVERAGE	-	1,87	-
MEDIAN		1,87	
STD DEVIATION	-	0,06	-
ROBUST AVERAGE		1,87	
ROBUST STD DEV		0,05	
U.O.M		0,02	
REPRODUCIBILITY			
UPPER LIMIT		2,11	
LOWER LIMIT		1,63	



COAL CONCEPTS - PROFICIENCY TESTING -JANUARY 2018			
ANALYTICAL PARAMETER : SO3 (%)			
	LAB ID	SO3 %	Z-SCORE
	1b	2,77	0,04
	3b	2,67	-0,14
	4b	2,79	0,07
	6b	2,92	0,30
	7b	2,80	0,09
	8b	3,15	0,70
	9b**	1,83	-1,62
	10b	2,51	-0,42
	13b	2,04	-1,26
	14b**	4,02	2,24
	15b	2,75	0,00
Number of results	-	11	11
OUTLIERS	-	0	-
AVERAGE	-	2,75	-
MEDIAN		2,77	
STD DEVIATION	-	0,57	-
ROBUST AVERAGE		2,71	
ROBUST STD DEV		0,48	
U.O.M		0,18	
REPRODUCIBILITY			
UPPER LIMIT		3,50	
LOWER LIMIT		2,00	



COAL CONCEPTS - PROFICIENCY TESTING - JANUARY 2018			
ANALYTICAL PARAMETER : P2O5 (%)			
	LAB ID	P2O5 %	Z-SCORE
	1b	0,42	-0,70
	3b	0,45	0,02
	4b	0,48	0,73
	6b	0,52	1,68
	7b	0,38	-1,58
	8b	0,40	-1,17
	9b	0,44	-0,22
	10b	0,44	-0,22
	13b	0,46	0,25
	14b	0,44	-0,22
	15b	0,51	1,44
Number of results	-	11	11
OUTLIERS	-	0	-
AVERAGE	-	0,45	-
MEDIAN		0,44	-
STD DEVIATION	-	0,04	-
ROBUST AVERAGE		0,45	
ROBUST STD DEV		0,05	
U.O.M		0,02	
REPRODUCIBILITY			
UPPER LIMIT		0,68	
LOWER LIMIT		0,22	



4. CONCLUSION

- 4.1 SiO₂ analysis has a positive bias z-score distribution. The Robust average and median compared well. No outliers were detected by Grubbs.
- 4.2 Al₂O₃ had positive bias z-score distribution. The mean and median and robust average compared well, indicating results reported were acceptable.
- 4.3 K₂O results were acceptable, the mean and median compared well. A negative bias Z-score distribution was observed.
- 4.4 MgO had a positive z-score distribution with the mean and median and robust average being similar indicating results were acceptable. One outlier was determined by Grubbs.
- 4.5 The trend for CaO indicated an equal z-score distribution. The mean, median and robust average were similar indicating an acceptable spread of results.
- 4.6 MnO₂ analysis results were acceptable indicated by the mean, median and robust average comparing well with each other. The Z-score trending is positively biased. Two outliers were determined by Grubbs
- 4.7 Fe₂O₃ analysis has a negative bias Z-score distribution. The mean, median and robust average were similar.
- 4.8 NaO - The Z-score distribution was not biased. The average and median were similar.
- 4.9 TiO₂ analysis results were acceptable with an equal Z-score trend. One outliers were observed.
- 4.10 SO₃ determination results were acceptable; the average, robust average and median is similar. A positive z-score distribution was observed.
- 4.11 P₂O₅ : An equal z-score distribution was observed. The results reported were well done as the mean, robust average and the median were similar.

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