



**COAL CONCEPTS**

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## **ASH CONSTITUENTS PROFICIENCY TESTING**

### **REPORT FORTY- SEVEN**

Revision: 00

### **Final report**

**MAY 2020**

**PARTICIPANT: RIO TINTO – RICHARDS BAY**



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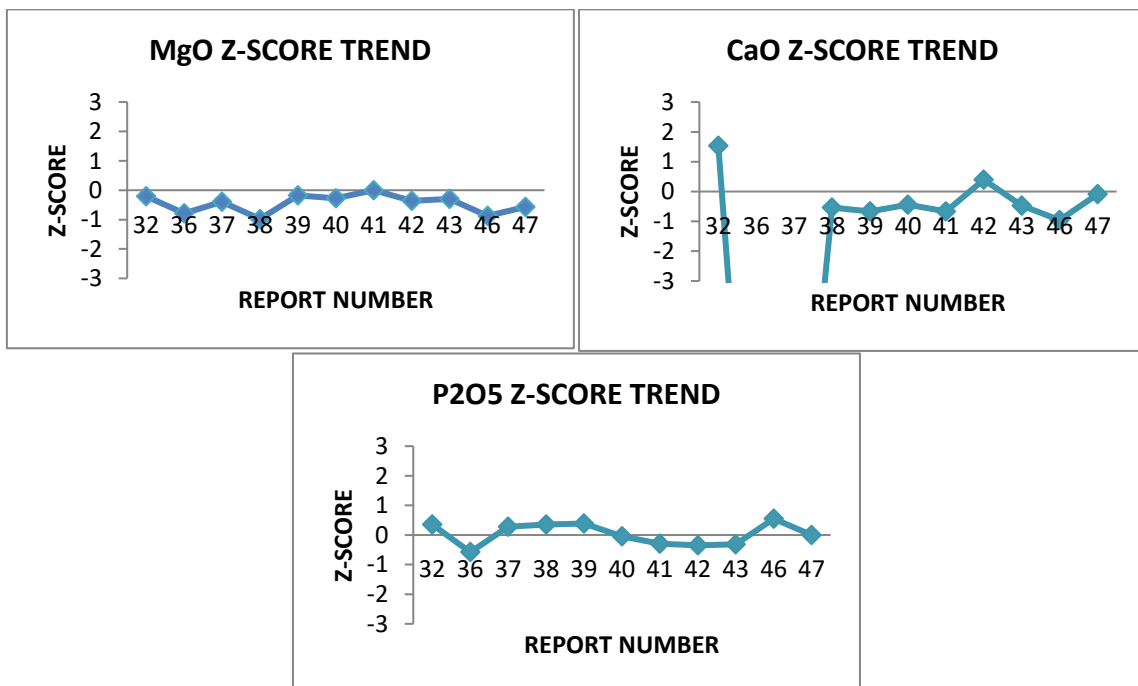
**SCHEME MANAGER: R BABOOLAL**

**THINKING QUALITY, QUALITY THINKING**

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## EXECUTIVE SUMMARY

1. Thirteen samples were sent to participants with 13 result submissions.
2. The total number of outliers found were as follows:
  - SiO<sub>2</sub> x1
  - Al<sub>2</sub>O<sub>3</sub> x1
  - MgO x 1
  - MnO x 1
  - TiO<sub>2</sub> x1
  - SO<sub>3</sub> x1
  - P<sub>2</sub>O<sub>5</sub> x 2
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 not applied to NaO and SO<sub>3</sub> due to data limitation
5. Use the z-score trend as an indication of the overall laboratory performance.



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Dear Participant

**RE: PROFICIENCY TESTING RESULTS FOR THE MONTH OF MAY 2020**

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

Your laboratory code is 22b

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
Bureau Veritas Inspectorate Laboratories Alton
Lafarge South Africa - Lichtenburg
Rio Tinto –Richards Bay
Ronewa Middelburg
SABS Commercial SOC - CSIR Laboratory
SABS Commercial SOC - Richards Bay Laboratory
Siza Coal Services - Middelburg
South 32 -Hotazel Manganese Mines
UIS Analytical Services
Morupule Coal Mine - Botswana

### 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 -212 $\mu$ m. 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. Seventy bottles of sample were weighed out. Ten bottles were randomly selected and tested for homogeneity SO<sub>3</sub> as the analyte.

### 3. HOMOGENEITY CHECK

SAMPLE NO.	TEST PORTION 1	TEST PORTION 2	sample av (Xt)	range (Wt)	range sqd
1	2.28	2.31	2.30	0.03	0.0009
2	2.16	2.11	2.14	0.05	0.0025
3	2.25	2.35	2.30	0.10	0.0100
4	2.17	2.22	2.20	0.05	0.0025
5	2.36	2.37	2.37	0.01	0.0001
GENERAL AVERAGE			2.26		
STANDARD DEVIATION			0.092		
WITHIN SAMPLE STANDARD DEVIATION			0.040		
BETWEEN SAMPLE STANDARD DEVIATION			0.087		

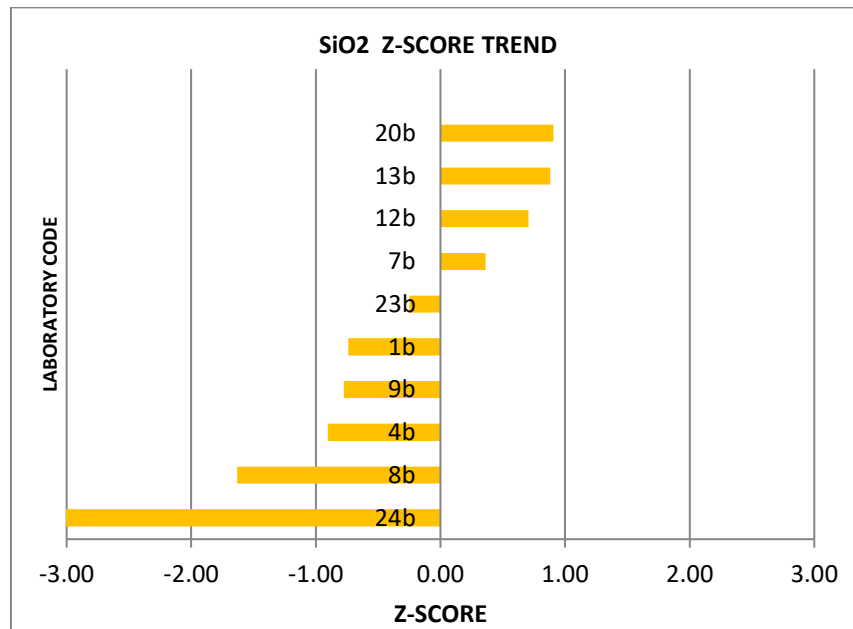
The between sample standard deviation must be  $\leq 0.3 \times \sigma$   
( $\sigma$  = std deviation for the proficiency assessment)

$\sigma = 0.651$  was used (repeatability for SO<sub>3</sub>)

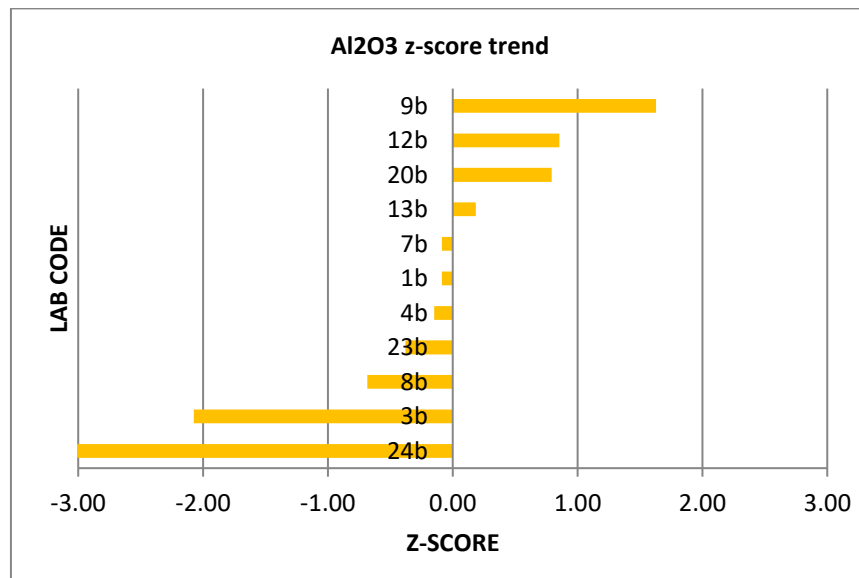
Hence  $0.3 \times 0.651 = 0.195$

**Since 0.087 < 0.195 the samples are homogenous**

COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020			
ANALYTICAL PARAMETER : SiO2 (%)			
	LAB ID	SiO2 %	Z-SCORE
	1b	52,14	-0,74
	3b	54,54	1,44
	4b	51,96	-0,90
	7b	53,35	0,36
	8b	51,16	-1,63
	9b	52,10	-0,78
	12b	53,73	0,71
	13b	53,92	0,88
	20b	53,95	0,91
	23b	52,68	-0,25
	<b>24b</b>	<b>25,68</b>	<b>-24,81</b>
<b>Number of results</b>	-	<b>11</b>	-
<b>OUTLIERS</b>	-	<b>1</b>	-
<b>AVERAGE</b>	-	<b>52,95</b>	-
<b>MEDIAN</b>		<b>53,02</b>	
<b>STD DEVIATION</b>	-	<b>1,10</b>	-
<b>ROBUST AVERAGE</b>	-	<b>52,98</b>	-
<b>ROBUST STD DEV</b>	-	<b>1,43</b>	-
<b>U.O.M</b>	-	<b>0,56</b>	-

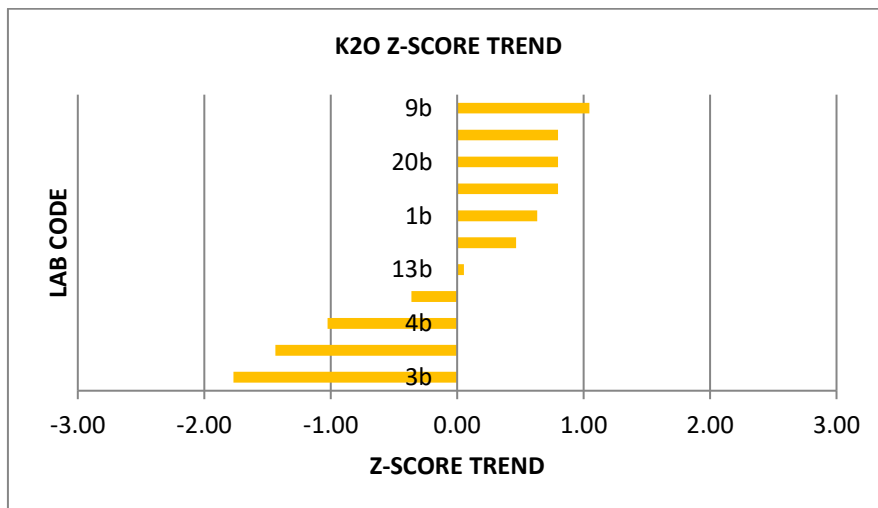


<b>COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020</b>			
<b>ANALYTICAL PARAMETER : Al<sub>2</sub>O<sub>3</sub> (%)</b>			
	<b>LAB ID</b>	<b>Al<sub>2</sub>O<sub>3</sub> %</b>	<b>Z-SCORE</b>
	1b	33,32	-0,09
	3b	31,42	-2,07
	4b	33,26	-0,15
	7b	33,32	-0,09
	8b	32,75	-0,68
	9b	34,96	1,63
	12b	34,22	0,85
	13b	33,58	0,19
	20b	34,16	0,79
	23b	33,04	-0,38
	<b><u>24b</u></b>	<b><u>16,78</u></b>	<b><u>-17,39</u></b>
<b>Number of results</b>	-	<b>11</b>	-
<b>OUTLIERS</b>	-	<b>1</b>	-
<b>AVERAGE</b>	-	<b>33,40</b>	-
<b>MEDIAN</b>	-	<b>33,32</b>	-
<b>STD DEVIATION</b>	-	<b>0,96</b>	-
<b>ROBUST AVERAGE</b>	-	<b>33,46</b>	-
<b>ROBUST STD DEV</b>	-	<b>0,86</b>	-
<b>U.O.M</b>	-	<b>0,34</b>	-

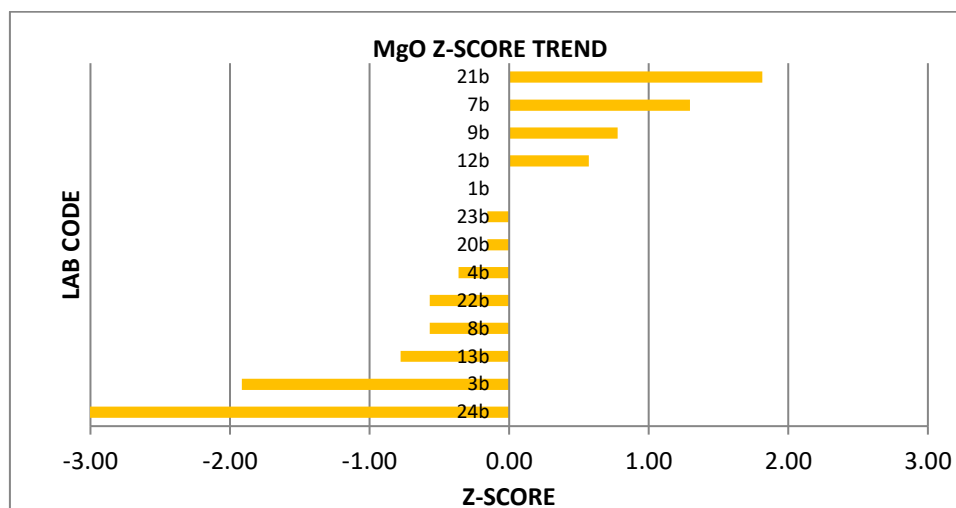




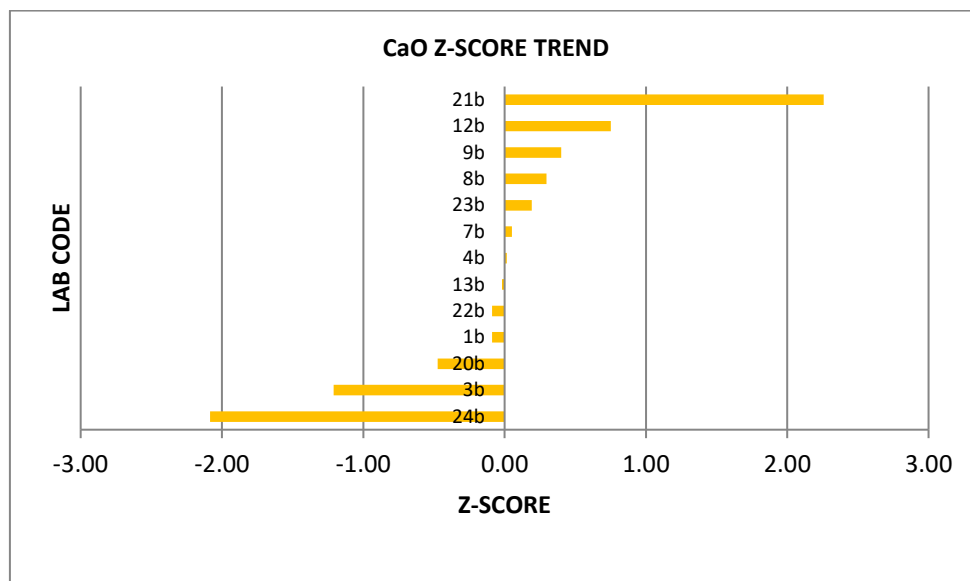
COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020			
ANALYTICAL PARAMETER : K2O (%)			
	LAB ID	K2O %	Z-SCORE
	1b	0,75	0,63
	3b	0,46	-1,77
	4b	0,55	-1,02
	7b	0,77	0,80
	8b	0,73	0,47
	9b	0,80	1,05
	13b	0,68	0,05
	20b	0,77	0,80
	21b	0,63	-0,36
	23b	0,77	0,80
	24b	0,50	-1,44
<b>Number of results</b>	-	<b>11</b>	-
<b>OUTLIERS</b>	-	<b>0</b>	-
<b>AVERAGE</b>	-	<b>0,67</b>	-
<b>MEDIAN</b>	-	<b>0,73</b>	-
<b>STD DEVIATION</b>	-	<b>0,121</b>	-
<b>ROBUST AVERAGE</b>	-	<b>0,68</b>	-
<b>ROBUST STD DEV</b>	-	<b>0,16</b>	-
<b>U.O.M</b>	-	<b>0,06</b>	-



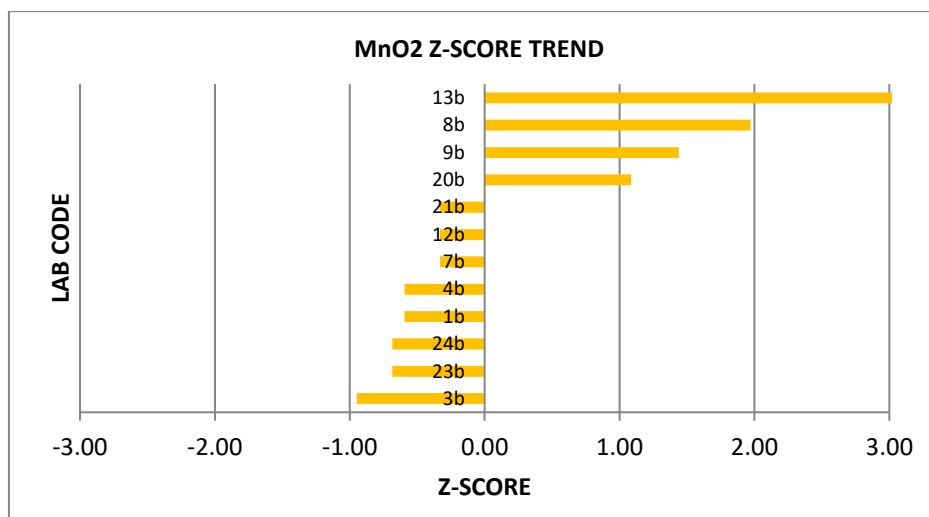
<b>COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020</b>			
<b>ANALYTICAL PARAMETER : MgO (%)</b>			
	<b>LAB ID</b>	<b>MgO %</b>	<b>Z-SCORE</b>
	1b	0,98	0,00
	3b	0,79	-1,92
	4b	0,94	-0,36
	7b	1,10	1,29
	8b	0,92	-0,57
	9b	1,05	0,78
	12b	1,03	0,57
	13b	0,90	-0,78
	20b	0,96	-0,16
	21b	1,15	1,81
	22b	0,92	-0,57
	23b	0,96	-0,16
	<b><u>24b</u></b>	<b><u>0,01</u></b>	<b><u>-10,00</u></b>
<b>Number of results</b>	-	<b>13</b>	-
<b>OUTLIERS</b>	-	<b>1</b>	-
<b>AVERAGE</b>	-	<b>0,98</b>	-
<b>MEDIAN</b>	-	<b>0,96</b>	-
<b>STD DEVIATION</b>	-	<b>0,10</b>	-
<b>ROBUST AVERAGE</b>	-	<b>0,98</b>	-
<b>ROBUST STD DEV</b>	-	<b>0,10</b>	-
<b>U.O.M</b>	-	<b>0,04</b>	-



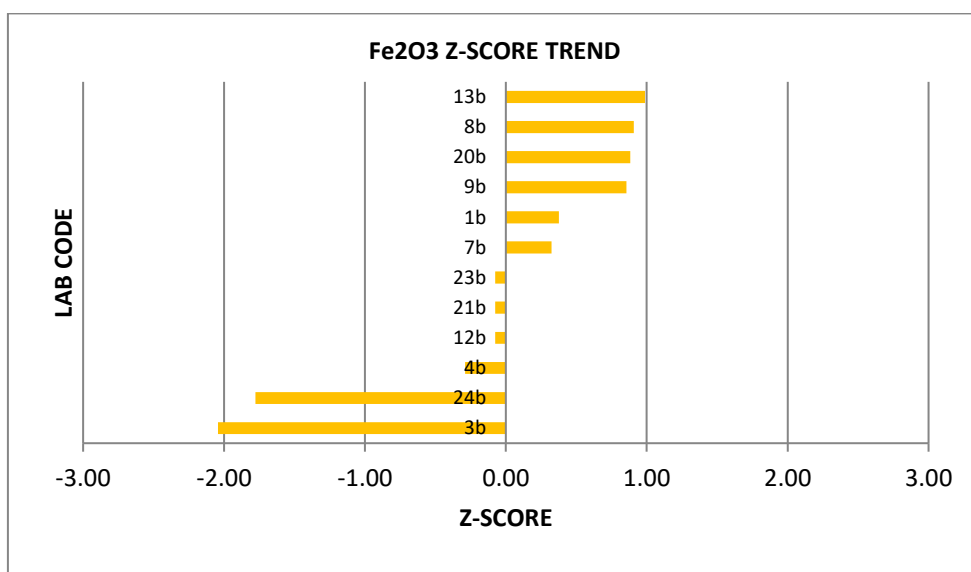
<b>COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020</b>			
<b>ANALYTICAL PARAMETER : CaO (%)</b>			
	<b>LAB ID</b>	<b>CaO %</b>	<b>Z-SCORE</b>
	1b	2,65	-0,09
	3b	2,33	-1,21
	4b	2,68	0,0
	7b	2,69	0,05
	8b	2,76	0,30
	9b	2,79	0,40
	12b	2,89	0,75
	13b	2,67	-0,02
	20b	2,54	-0,47
	21b	3,32	2,26
	22b	2,65	-0,09
	23b	2,73	0,19
	24b	2,08	-2,08
<b>Number of results</b>	-	<b>13</b>	-
<b>OUTLIERS</b>	-	<b>0</b>	-
<b>AVERAGE</b>	-	<b>2,68</b>	-
<b>MEDIAN</b>	-	<b>2,68</b>	-
<b>STD DEVIATION</b>	-	<b>0,29</b>	-
<b>ROBUST AVERAGE</b>	-	<b>2,67</b>	-
<b>ROBUST STD DEV</b>	-	<b>0,21</b>	-
<b>U.O.M</b>	-	<b>0,07</b>	-



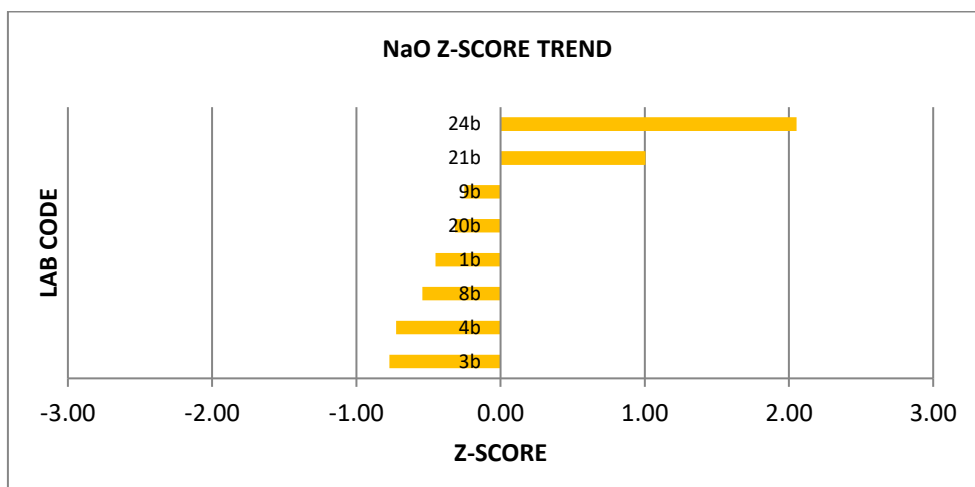
COAL CONCEPTS - PROFICIENCY TESTING -MAY 2020			
ANALYTICAL PARAMETER : MnO2 (%)			
	LAB ID	MnO2 %	Z-SCORE
	1b	0,031	-0,60
	3b	0,027	-0,95
	4b	0,031	-0,60
	7b	0,034	-0,33
	8b	0,060	1,97
	9b	0,054	1,44
	12b	0,034	-0,33
	<b>13b</b>	<b>0,650</b>	<b>54,16</b>
	20b	0,050	1,09
	21b	0,034	-0,33
	23b	0,030	-0,68
	24b	0,030	-0,68
<b>Number of results</b>	-	<b>12</b>	-
<b>OUTLIERS</b>	-	<b>1</b>	-
<b>AVERAGE</b>	-	<b>0,038</b>	-
<b>MEDIAN</b>	-	<b>0,034</b>	-
<b>STD DEVIATION</b>	-	<b>0,011</b>	-
<b>ROBUST AVERAGE</b>	-	<b>0,036</b>	-
<b>ROBUST STD DEV</b>	-	<b>0,013</b>	-
<b>U.O.M</b>	-	<b>0,005</b>	-



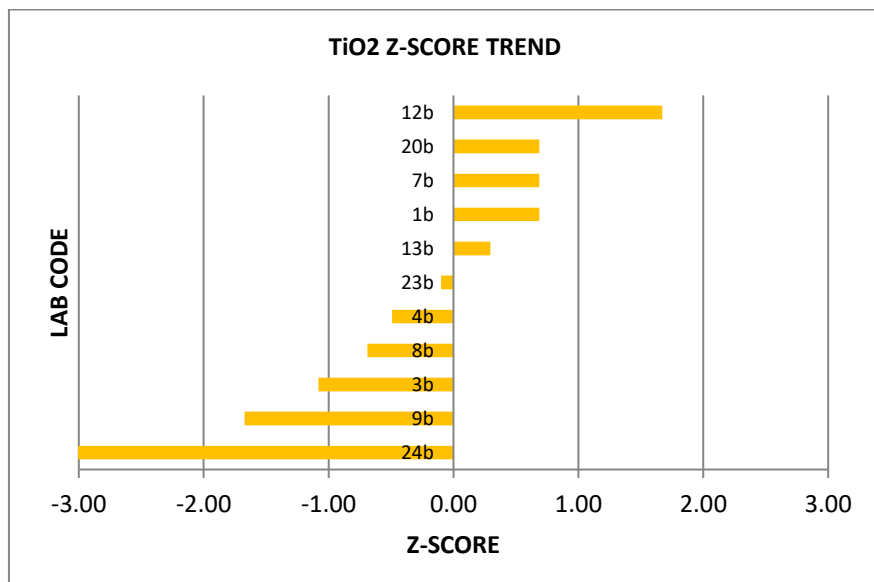
<b>COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020</b>			
<b>ANALYTICAL PARAMETER : Fe2O3 (%)</b>			
	<b>LAB ID</b>	<b>Fe2O3 %</b>	<b>Z-SCORE</b>
	1b	4,14	0,38
	3b	3,23	-2,04
	4b	3,89	-0,29
	7b	4,12	0,32
	8b	4,34	0,91
	9b	4,32	0,86
	12b	3,97	-0,08
	13b	4,37	0,99
	20b	4,33	0,88
	21b	3,97	-0,08
	23b	3,97	-0,08
	24b	3,33	-1,78
<b>Number of results</b>	-	<b>12</b>	-
<b>OUTLIERS</b>	-	<b>0</b>	-
<b>AVERAGE</b>	-	<b>4,00</b>	-
<b>MEDIAN</b>	-	<b>4,05</b>	-
<b>STD DEVIATION</b>	-	<b>0,38</b>	-
<b>ROBUST AVERAGE</b>	-	<b>4,04</b>	-
<b>ROBUST STD DEV</b>	-	<b>0,45</b>	-
<b>U.O.M</b>	-	<b>0,16</b>	-



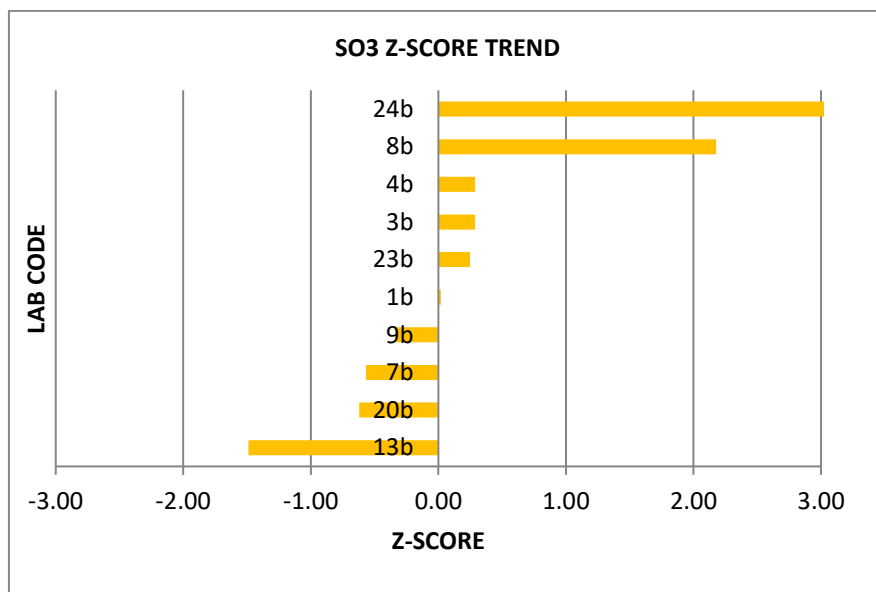
<b>COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020</b>			
<b>ANALYTICAL PARAMETER : NaO (%)</b>			
	<b>LAB ID</b>	<b>NaO %</b>	<b>Z-SCORE</b>
	1b	0,22	-0,45
	3b	0,15	-0,77
	4b	0,16	-0,72
	8b	0,20	-0,54
	9b	0,26	-0,25
	20b	0,25	-0,32
	21b	0,54	1,00
	24b	0,77	2,05
<b>Number of results</b>	-	<b>8</b>	-
<b>OUTLIERS</b>	-	<b>0</b>	-
<b>AVERAGE</b>	-	<b>0,32</b>	-
<b>MEDIAN</b>	-	<b>0,24</b>	-
<b>STD DEVIATION</b>	-	<b>0,22</b>	-



<b>COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020</b>			
<b>ANALYTICAL PARAMETER : TiO2 (%)</b>			
	<b>LAB ID</b>	<b>TiO2 %</b>	<b>Z-SCORE</b>
	1b	1,93	0,69
	3b	1,84	-1,08
	4b	1,87	-0,49
	7b	1,93	0,69
	8b	1,86	-0,69
	9b	1,81	-1,67
	12b	1,98	1,67
	13b	1,91	0,30
	20b	1,93	0,69
	23b	1,89	-0,10
	<b>24b</b>	<b>1,13</b>	<b>-15,05</b>
<b>Number of results</b>	-	<b>11</b>	-
<b>OUTLIERS</b>	-	<b>1</b>	-
<b>AVERAGE</b>	-	<b>1,90</b>	-
<b>MEDIAN</b>	-	<b>1,90</b>	-
<b>STD DEVIATION</b>	-	<b>0,05</b>	-
<b>ROBUST AVERAGE</b>	-	<b>1,90</b>	-
<b>ROBUST STD DEV</b>	-	<b>0,06</b>	-
<b>U.O.M</b>	-	<b>0,02</b>	-

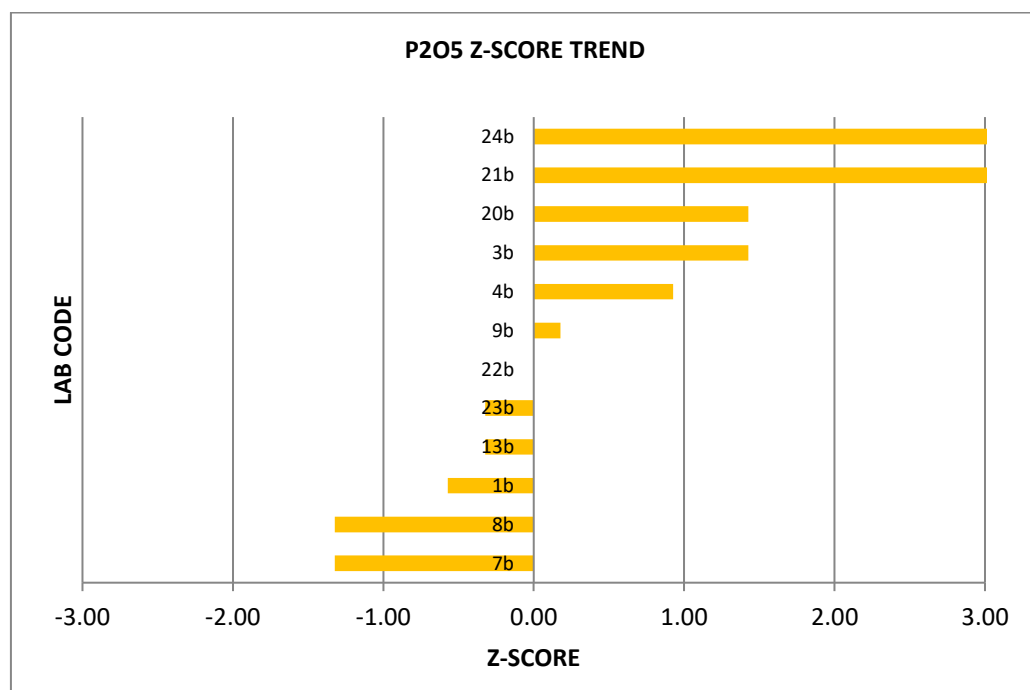


<b>COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020</b>			
<b>ANALYTICAL PARAMETER : SO3 (%)</b>			
	<b>LAB ID</b>	<b>SO3 %</b>	<b>Z-SCORE</b>
	1b	2,65	0,02
	3b	2,86	0,29
	4b	2,86	0,29
	7b	2,19	-0,57
	8b	4,34	2,18
	9b	2,37	-0,34
	20b	2,15	-0,62
	13b	1,47	-1,49
	23b	2,83	0,25
	<b>24b</b>	<b>6,02</b>	<b>4,32</b>
<b>Number of results</b>	-	<b>10</b>	-
<b>OUTLIERS</b>	-	<b>1</b>	-
<b>AVERAGE</b>	-	<b>2,64</b>	-
<b>MEDIAN</b>	-	<b>2,65</b>	-
<b>STD DEVIATION</b>	-	<b>0,78</b>	-





COAL CONCEPTS - PROFICIENCY TESTING - MAY 2020			
ANALYTICAL PARAMETER : P2O5 (%)			
	LAB ID	P2O5 %	Z-SCORE
	1b	0,34	-0,57
	3b	0,42	1,43
	4b	0,40	0,93
	7b	0,31	-1,32
	8b	0,31	-1,32
	9b	0,37	0,18
	13b	0,35	-0,32
	20b	0,42	1,43
	<b><u>21b</u></b>	<b><u>0,59</u></b>	<b><u>5,67</u></b>
	22b	0,36	0,00
	23b	0,35	-0,32
	<b><u>24b</u></b>	<b><u>0,79</u></b>	<b><u>10,67</u></b>
<b>Number of results</b>	-	<b>12</b>	-
<b>OUTLIERS</b>	-	<b>2</b>	-
<b>AVERAGE</b>	-	<b>0,36</b>	-
<b>MEDIAN</b>	-	<b>0,35</b>	-
<b>STD DEVIATION</b>	-	<b>0,04</b>	-
<b>ROBUST AVERAGE</b>	-	<b>0,36</b>	-
<b>ROBUST STD DEV</b>	-	<b>0,06</b>	-
<b>U.O.M</b>	-	<b>0,02</b>	-



#### 4. CONCLUSION

- 4.1 SiO<sub>2</sub> analysis has an almost even z-score distribution. The robust average, median and average compare well, indicating results reported are acceptable. One outlier was detected by Grubbs, possible swapped sample.
- 4.2 Al<sub>2</sub>O<sub>3</sub> has an almost even z-score distribution. The robust average, median and average also compares well. One outlier was detected by Grubbs, possible swapped sample.
- 4.3 K<sub>2</sub>O Z-Score distribution is even. No outliers detected.
- 4.4 MgO has 1 outlier with a positive bias z-score trend, the rest of the results comparing well.
- 4.5 The trend for CaO is evenly distributed. Results compared well.
- 4.6 MnO<sub>2</sub>: The Z-score trending is negatively biased. The robust average, median and average compare well, indicating results reported are acceptable.
- 4.7 Acceptable results received on Fe<sub>2</sub>O<sub>3</sub> determination. No outliers or widespread results. The trending was even.
- 4.8 NaO – trending was negatively biased, the results were wide spread.
- 4.9 TiO<sub>2</sub> analysis results are acceptable. Robust average, Mean and Median compare well. The Z-score trending is even. One outlier was detected by Grubbs.
- 4.10 SO<sub>3</sub> .: Even Z-score trending, results are acceptable.
- 4.11P<sub>2</sub>O<sub>5</sub>: Analysis generally well done with an even Z-score trending. Low standard deviation of 0.04

**COAL CONCEPTS: Terms and Conditions**Return 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