AZURESKY PTY LTD PROFICIENCY TESTING

GENERAL ANALYSIS REPORT

Laboratory Code

Final Report

Report No: 10

Date Issued: 5th November 2025

Document Compiled by:

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Signature: 

1. Letter to participant

- Azuresky (Pty) Ltd would like to express gratitude to **LAB NAME** participating in this round of the proficiency testing scheme.
- Each participant is allocated a random, unique number for the programme to enable total confidentiality of results.
- The unique identification number for your laboratory is **LAB ID.**

Participants are encouraged to submit any comments or queries regarding the results or operation of the scheme to info@azuresky.it.com or nonhlanhla@azuresky.it.com.

2. Executive summary

Azuresky Pty Ltd is a proficiency testing scheme provider and certified reference material producer. We aim to produce a homogeneous proficiency test sample and stable certified reference material to be used for the evaluation of participant performance against pre-defined criteria in interlaboratory comparison programs specific to coal testing methods and calibration of coal testing equipment.

The source of the coal samples for this round was acquired from a mine located in Mpumalanga, and the coal type is bituminous.

The identity of the PT samples dispatched for this round is " Proficiency Testing Sample A October 2025".

The total number of participants for this round was 28.

When the sample size is sufficiently large, the sampling distribution of the sample mean approaches a normal distribution, regardless of the shape of the original population distribution. This assumption underpins all statistical analyses and calculations presented in this report.

Only two significant outliers were identified in this report, relating to the ISO Volatile Matter and Total Sulphur.

In accordance with SANAS R80, small interlaboratory comparisons are defined as those with seven or fewer participants. As this scheme is not classified as a small ILC, Azuresky applies an internal threshold of n ≥ 10 for the calculation and reporting of z-scores. This criterion is applied to ensure that statistical estimates (mean, standard deviation, and z-scores) are robust and not unduly influenced by small datasets. Where the number of participants is fewer than 10, only indicative results on an air-dry basis are provided.

Interpretation of trends requires a minimum of five data points to ensure a meaningful analysis, while graphical representation necessitates at least two data points to establish a visual comparison.

- Quick ash: Acceptable trend
- Calorific Value: Acceptable trend
- Total Sulphur: Outlier detected, and the results are negatively skewed.

3. List of participants

No	Lab Name
1	Azuresky Pty Ltd
2	Best Enough Laboratory Services NCC
3	Best Enough Laboratory Services Springs
4	Bestech Zomhlaba Lakeside
5	Eskom Arnot Power Station
6	Eskom Grootvlei Power Station
7	Eskom Kendal Power Station
8	Eskom Research and Testing
9	Mfulawamanzi Kleinfontein
10	Mfulawamanzi Main Laboratory
11	Mfulawamanzi Piet Retief
12	Noko Analytical Services Piet Retief
13	Noko Analytical Services Witbank
14	Sibonisiwe Coal Laboratory Services Arnot Laboratory
15	Sibonisiwe Coal Laboratory Services Clewer
16	Sibonisiwe Coal Laboratory Services Main Lab
17	Sibonisiwe Coal Laboratory Services RMC
18	Sibonisiwe Coal Laboratory Services Wescoal
19	Siza Coal Services Dundee
20	Siza Coal Services Kinross
21	Siza Coal Services Leeuwpan
22	Siza Coal Services Matsambisa
23	Siza Coal Services Mgayo
24	Siza Coal Services Middelburg

25	Siza Coal Services NBC
26	Siza Coal Services Sasolburg
27	Umzamo Analytical Services Hendrina
28	Umzamo Analytical Services Main lab

4. Homogeneity check

10 random samples were extracted from the batch during packaging. These were used for homogeneity assessment prior to the distribution of samples to participants.

	Dry basis				
# Sample	**%R1**	**%R2**	**%Sample av (Xt)**	**Range (Wt)**	**Range sqd**
1	13.53	13.39	13.46	0.1421	0.0202
2	13.78	13.79	13.78	0.0071	0.0000
3	13.79	13.55	13.67	0.2399	0.0576
4	13.81	13.81	13.81	0.0046	0.0000
5	13.82	13.87	13.84	0.0470	0.0022
6	13.84	13.93	13.88	0.0833	0.0069
7	14.10	14.06	14.08	0.0458	0.0021
8	13.70	13.75	13.72	0.0451	0.0020
9	13.72	13.81	13.77	0.0923	0.0085
10	14.25	14.29	14.27	0.0381	0.0014
Overall Average			13.83		
Standard Deviation			0.22		
SSwithin			0.929		
SSbetween			0.0006		
õpt			3.784		
Check value			1.135		

where: õpt is the standard deviation from the pt

Conclusion : SSbetween< Check value. Thus, homogeneity is sufficient.

5. Stability check

10 samples which were used for the homogeneity assessment were analysed to check for stability, the results are as following:

	%Dry basis				
# Sample	%R1	%R2	Sample av (Xt)	Range (Wt)	Range sqd
1	13.79	14.03	13.91	0.2371	0.0562
2	13.97	13.77	13.87	0.1959	0.0384
3	13.84	13.63	13.73	0.2062	0.0425
4	13.23	13.18	13.20	0.0515	0.0027
5	13.75	13.74	13.75	0.0103	0.0001
6	13.82	13.75	13.79	0.0722	0.0052
7	13.71	13.77	13.74	0.0619	0.0038
8	13.68	13.59	13.63	0.0928	0.0086
9	13.68	13.85	13.76	0.1649	0.0272
10	13.75	13.77	13.76	0.0206	0.0004
Overall Average			13.72		
Standard Deviation			0.20		
SSwithin			0.784		
SSbetween			0.001		

Check value from the homogeneity assessment is	1.135
The mean difference between homogeneity and stability assessments	0.114

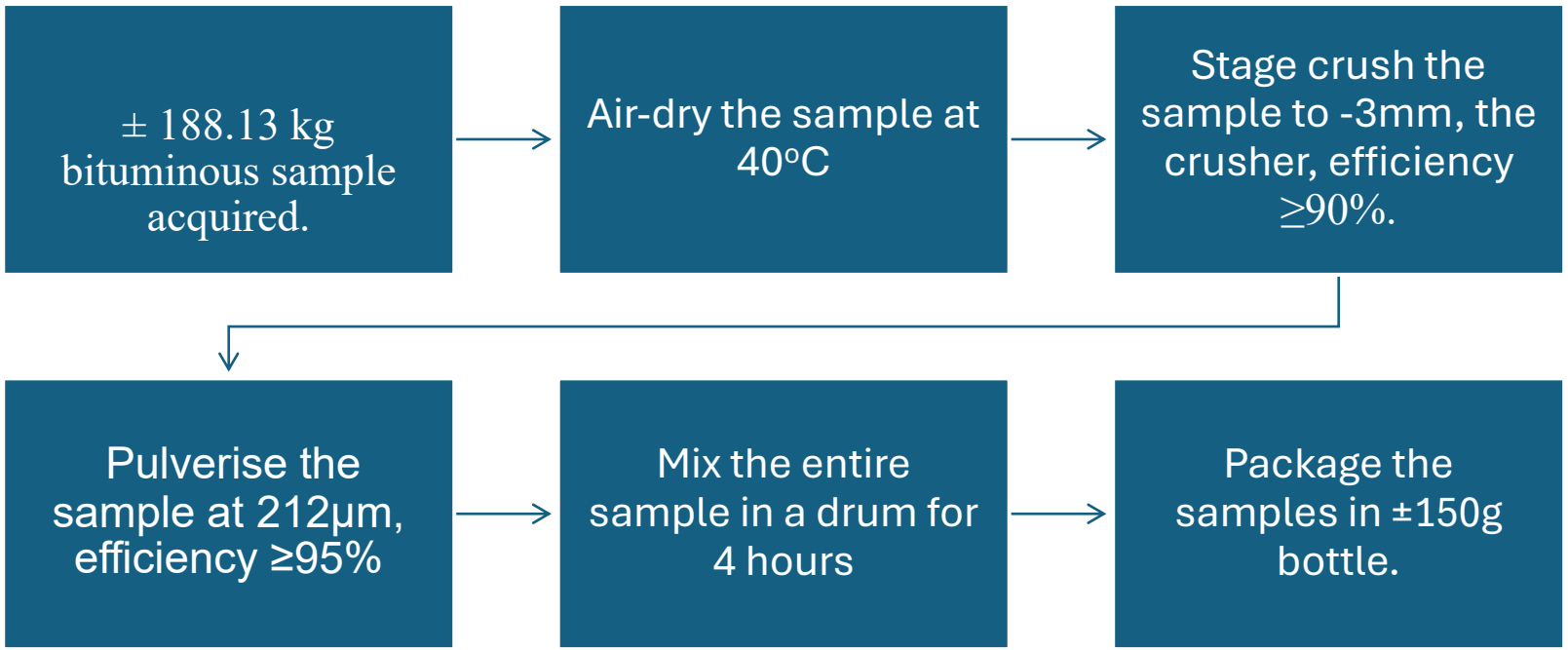
Since 0.114<1.135, the PT samples meet stability requirements

6. Sample preparation

The sample preparation procedure was conducted in accordance with the guidelines outlined in ISO 13909-4, ISO/IEC 17025, ISO/IEC 17043, and ISO 17034. Before the distribution of samples, ten random sub-samples of approximately 150 grams each were drawn using the flat-and-heap method from the 600 grams obtained from the homogeneity drum.

None of the activities for the PT program were subcontracted.

Sample preparation process flow:



7. Measurement Protocol and identification of the measurement standard (ISO/IEC 17043:2023, clause 7.1.2)

The analysis performed for this round, together with the SI units, is stipulated below:

- Calorific Value measured in MJ/Kg
- ISO Ash in % m/m
- Quick Ash in % m/m
- Total Sulphur %
- Moisture in Analysis sample % m/m
- Ash Fusion Temperature (°C)
- Hydrogen %
- Total Carbon %

8. Measurement Results

	AIR DRY BASIS						ASH FUSION TEMPERATURE (°C)			
Lab ID	**%Moisture**	**%Quick Ash**	**% ISO Ash**	**% ISO Volatile**	**Calorific Value MJ/Kg**	**%Total Sulphur**	**DT**	**ST**	**HT**	**FT**
1	2.8	13.7	***	***	27.82	0.86	***	***	***	***
2	2.5	13.8	13.9	29.7	27.50	***	***	***	***	***
4	3.2	13.6	13.6	30.2	27.71	1.06	***	***	***	***
5	2.3	13.1	13.5	30.3	27.74	0.99	***	***	***	***
6	2.4	13.8	13.7	30.2	27.22	1.03	1320	1330	1350	1370
7	2.6	13.6	13.6	30.4	28.34	1.00	***	***	***	***
12	2.7	***	13.3	29.6	27.69	0.99	***	***	***	***
15	3.2	***	13.1	29.6	28.43	1.01	***	***	***	***
17	3.1	***	13.3	29.6	27.59	1.07	***	***	***	***
19	2.9	13.2	13.4	30.1	27.73	1.04	1350	1360	1370	1400
20	2.4	***	13.9	30.3	27.05	1.06	***	***	***	***
25	2.1	13.9	13.7	30.4	27.20	1.02	1320	1340	1360	1370
27	3.0	13.9	***	29.9	28.29	1.01	***	***	***	***
28	2.6	***	13.3	29.7	27.98	1.08	1310	1320	1340	1370
29	2.9	13.7	***	29.8	27.74	1.11	***	***	***	***
33	2.7	****	13.1	29.7	27.73	1.06	1330	1340	1370	1430
40	2.8	***	13.2	30.0	27.72	1.04	***	***	***	***
44	3.2	***	13.1	29.6	28.43	1.01	***	***	***	***
46	3.4	***	13.8	29.3	27.92	0.98	***	***	***	***
47	2.7	13.5	***	30.4	27.40	0.93	***	***	***	***
49	1.8	13.5	13.6	31.0	27.32	***	***	***	***	***
65	3.9	***	13.6	30.3	27.77	1.01	***	***	***	***
66	2.8	13.2	13.3	27.9	27.65	***	***	***	***	***
67	2.8	13.5	13.5	30.6	27.60	***	***	***	***	***
69	3.2	***	13.3	29.5	27.58	1.03	***	***	***	***
71	3.3	13.8	***	29.5	27.59	1.03	***	***	***	***
72	3.6	13.6	***	29.4	28.40	***	***	***	***	***
73	3.0	***	13.0	29.3	27.82	***	***	***	***	***

	Dry basis										
Lab ID	**% ISO Moisture**	**% Quick Ash**	**Z-score**	**% ISO Ash**	**Z-score**	**%Volatile**	**Z-score**	**Calorific Value (MJ/Kg)**	**Z-score**	**%Total Sulphur**	**Z-score**
1	2.8	14.1	0.52	***	***	***	***	28.62	0.13	0.88	**-4.21**
2	2.5	14.2	0.69	13.9	1.67	29.7	-0.53	28.21	-0.78	***	***
4	3.2	14.1	0.44	13.6	0.72	30.2	0.66	28.64	0.16	1.10	0.93
5	2.3	13.4	-1.96	13.5	0.06	30.3	0.82	28.39	-0.37	1.01	-1.07
6	2.4	14.1	0.64	13.7	0.94	30.2	0.59	27.89	-1.46	1.06	-0.05
7	2.6	14.0	-0.01	13.6	0.58	30.4	1.04	29.10	1.15	1.03	-0.75
12	2.7	***	***	13.3	-0.52	29.6	-0.76	28.46	-0.23	1.02	-0.97
15	3.2	***	***	13.1	-1.25	29.6	-0.76	29.37	1.74	1.04	-0.34
17	3.1	***	***	13.3	-0.52	29.6	-0.76	28.47	-0.20	1.10	1.15
19	2.9	13.6	-1.36	13.4	-0.16	30.1	0.37	28.56	-0.02	1.07	0.34
20	2.4	***	***	13.9	1.67	30.3	0.82	27.72	-1.84	1.09	0.70
25	2.1	14.2	0.85	13.7	0.94	30.4	1.04	27.78	-1.69	1.04	-0.37
27	3.0	14.3	1.33	***	***	29.9	-0.08	29.16	1.30	1.04	-0.39
28	2.6	***	***	13.3	-0.52	29.7	-0.53	28.73	0.35	1.11	1.26
29	2.9	14.1	0.53	***	***	29.8	-0.31	28.57	0.01	1.14	2.10
33	2.7	***	***	13.1	-1.25	29.7	-0.53	28.50	-0.14	1.09	0.79
40	2.8	***	***	13.2	-1.00	30.0	0.08	28.52	-0.09	1.07	0.32
44	3.2	***	***	13.1	-1.25	29.6	-0.76	29.37	1.74	1.04	-0.34
46	3.4	***	***	13.8	1.31	29.3	-1.43	28.90	0.73	1.01	-1.04
47	2.7	13.9	-0.33	***	***	30.4	1.04	28.16	-0.88	0.96	-2.48
49	1.8	13.7	-0.96	13.6	0.58	31.0	2.35	27.81	-1.63	***	***
65	3.9	***	***	13.6	0.58	30.3	0.82	28.90	0.72	1.05	-0.15
66	2.8	13.5	-1.56	13.3	-0.52	27.9	**-4.49**	28.45	-0.26	***	***
67	2.8	13.8	-0.47	13.5	0.28	30.6	1.49	28.40	-0.37	***	***
69	3.2	***	***	13.3	-0.52	29.5	-0.98	28.49	-0.16	1.06	0.17
71	3.3	14.3	1.12	***	***	29.5	-0.98	28.53	-0.07	1.07	0.19
72	3.6	14.1	0.52	***	***	29.4	-1.21	29.46	1.94	***	***
73	3.0	***	***	13.0	-1.80	29.3	-1.54	28.68	0.25	***	***

		Dry basis										
	Lab ID	% ISO Moisture	% Quick Ash	Z-score	% ISO Ash	Z-score	%Volatile	Z-score	Calorific Value (MJ/Kg)	Z-score	%Total Sulphur	Z-score
# of participants	-	28	16	-	22	-	27	-	28	-	22	-
Outliers	-	0	0	-	0	-	1	-	0	-	1	-
# of participants after outlier elimination	-	28	16	-	22	-	26	-	28	-	21	-
Average	-	2.9	14.0	-	13.4	-	29.9	-	28.57	-	1.06	-
Standard deviation	-	0.45	0.27	-	0.27	-	0.44	-	0.46	-	0.04	-
%RSD	-	-	1.96	-	2.03	-	1.48	-	1.62	-	3.87	-
Median	-	-	14.1	-	13.5	-	30.0	-	28.52	-	1.05	-
UoM	-	-	0.07		0.06		0.09		0.09		0.01	
Min	-	-	13.4	-	13.1	-	27.9	-	27.7	-	0.9	-
Max	-	-	14.3	-	13.9	-	31.0	-	29.37	-	1.14	-
standard error	-	-	0.16	-	0.13	-	0.20	-	0.20	-	0.02	-
Lower confidence limit	-	-	13.8	-	13.3	-	29.7	-	28.37	-	1.04	-
Upper confidence limit	-	-	14.1	-	13.6	-	30.1	-	28.77	-	1.08	-
Lower confidence limit 3x SE	-	-	13.5	-	13.0	-	29.3	-	27.97	-	1.00	-
Upper confidence limit 3x SE	-	-	14.5	-	13.8	-	30.5	-	29.16	-	1.12	-

Key: "**" or "blank" represents no participation**

9. Reference Value(s) and their establishment (SANAS R80, clause 7.3)

The assignment of reference values has been carried out in accordance with the requirements of ISO/IEC 17043:2023 (clause 7.7) and ISO 17034:2016 (clauses 7.12–7.13). These standards provide internationally accepted guidance on the establishment of reference values, including the traceability of results, appropriate statistical treatment, and the evaluation of measurement uncertainty.

Disclosure of Assigned Values

In line with the requirements of **ISO/IEC 17043:2023, clause 7.2.3.5**, measures are in place to ensure that participants cannot gain an advantage through early disclosure of assigned values. The following practices are applied:

- **Single Submission:** Each participant is allowed to submit their results only once. After submission, no edits or resubmissions are permitted.
- **Post-closure Analysis:** All statistical evaluation and assignment of values are performed only after the submission deadline has passed.
- **Simultaneous Release:** Final PT reports, including assigned values, are issued to all participants at the same time. This ensures that no participant has access to assigned values ahead of others.

Through these practices, the integrity of the proficiency testing process is maintained, and participants are assured of fair and unbiased evaluation.

10. Evaluation of the measurement results

- Outliers
  - Total Sulphur x1, Lab ID 1; Volatile Matter x1, Lab ID 66 (see dry base table for z-scores)
- All results are accepted as correct and cannot be changed after the release of the report.

Z-Score Evaluation Criteria:

- A z-score within the range of **±1** is considered **acceptable**.
- A z-score within the range of **±2** is regarded as **satisfactory**.
- A z-score between **±2 and ±3** is classified as **questionable**, indicating potential issues that warrant further investigation.
- A z-score exceeding **±3** is deemed **unsatisfactory** and is treated as an **outlier.**

Figure 1: Volatile matter z-scores

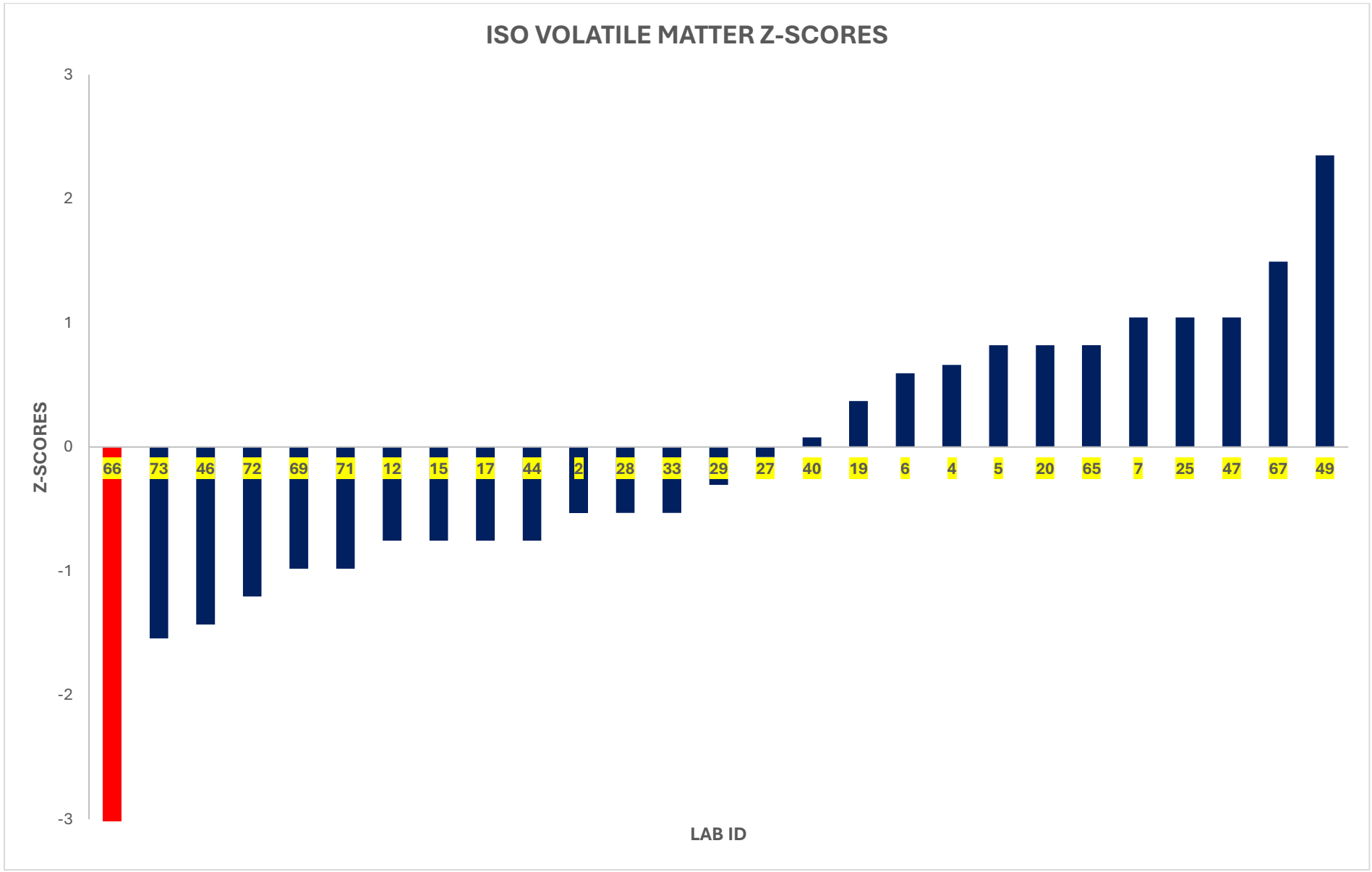


figure 2: ISO ash z-scores

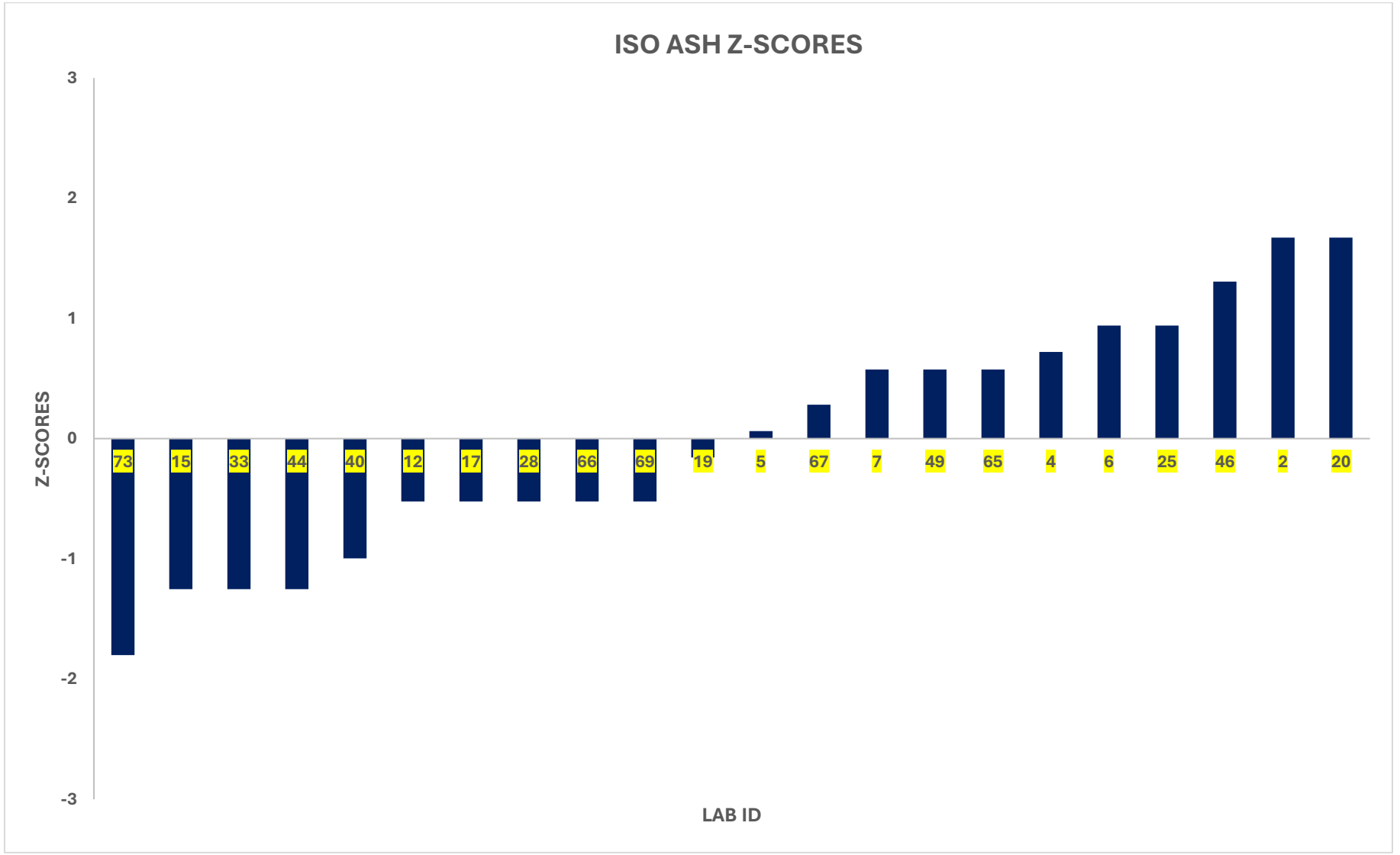


Figure 3: Quick Ash z-scores

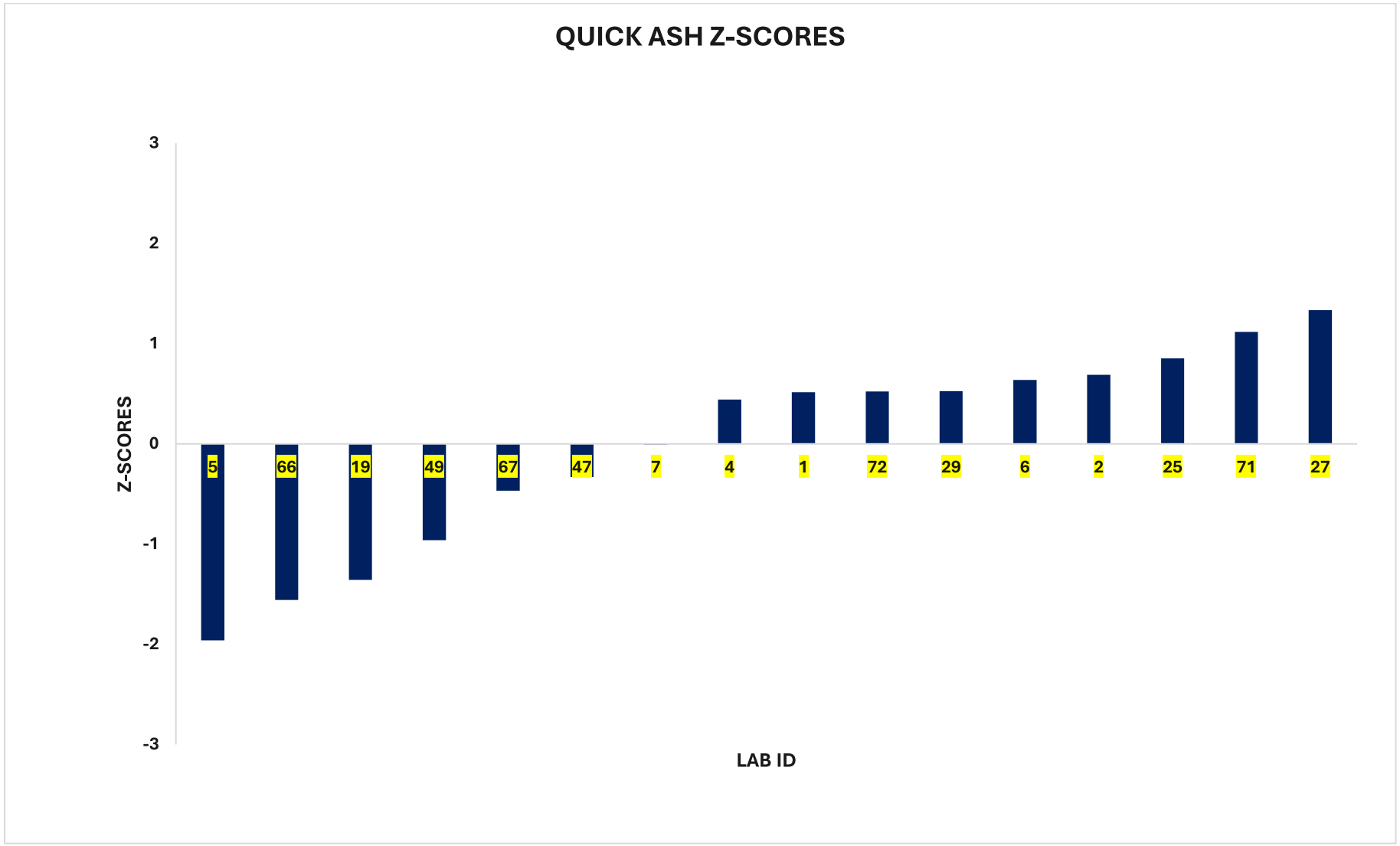


Figure 4: Calorific Value z-scores

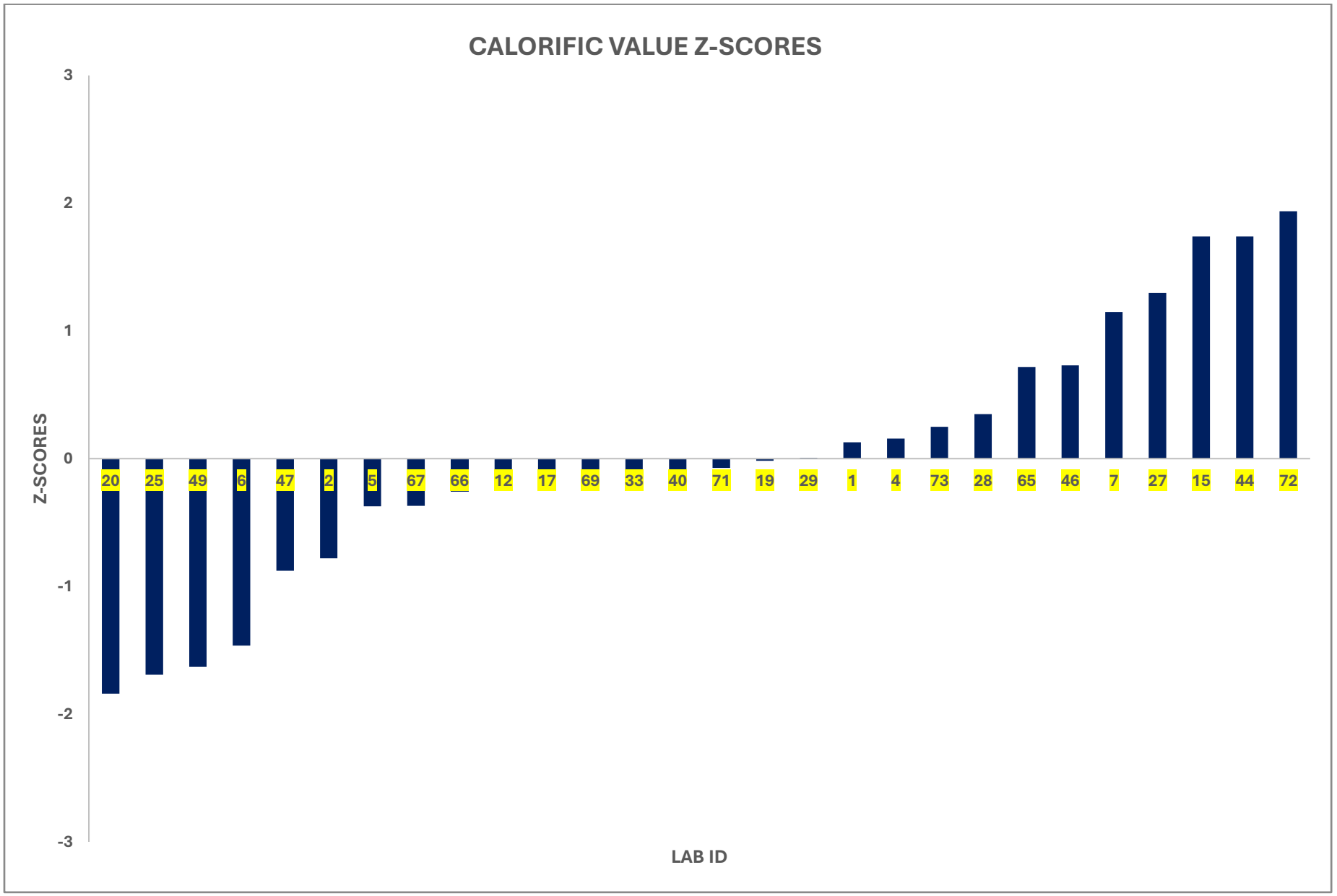
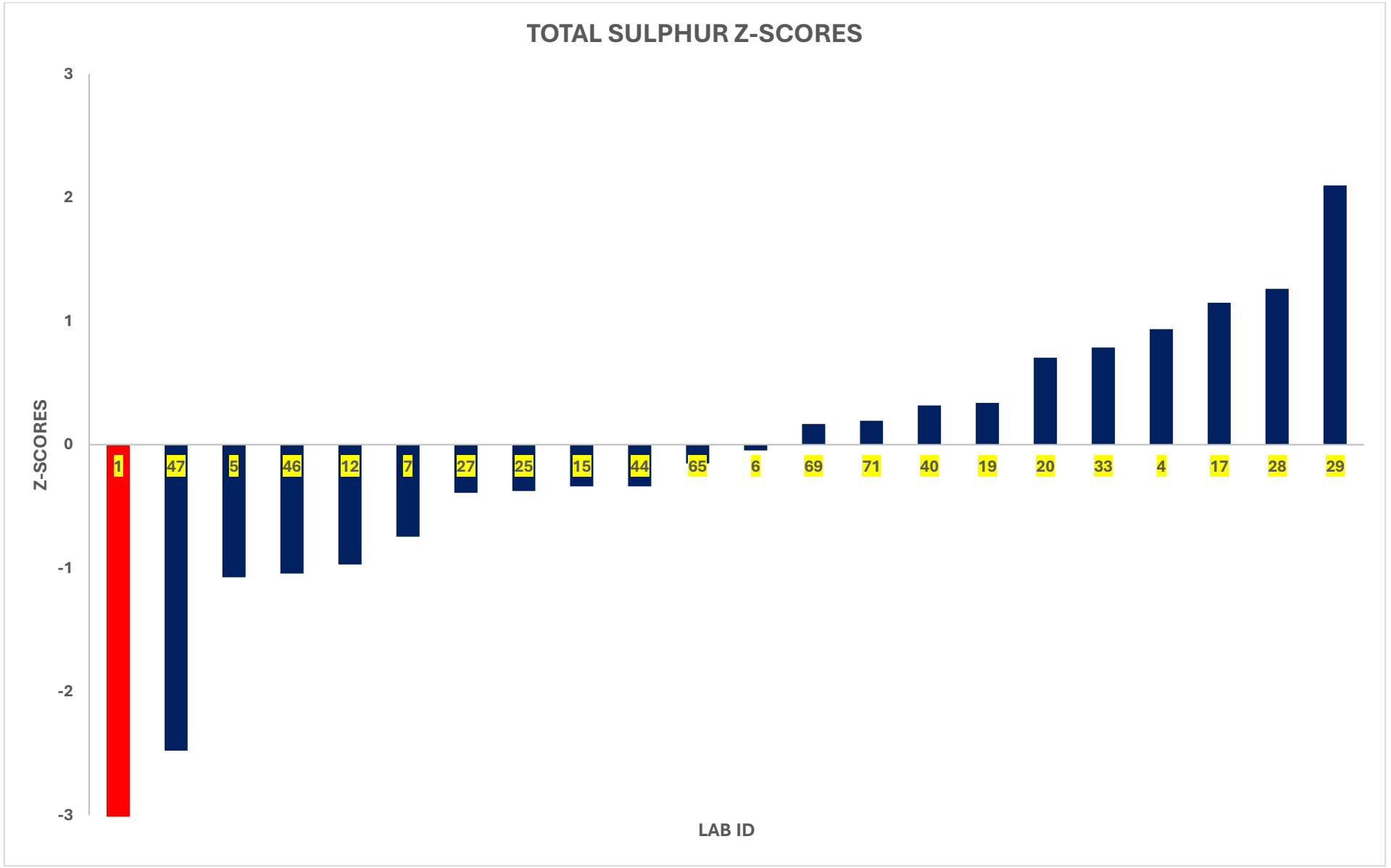


Figure 5: Total Sulphur z-scores



11. General Conclusions

11.1. ISO Moisture

- Results from 28 laboratories ranged from 1.8% to 3.9%, with a mean value of 2.86% and a standard deviation of 0.45%.
- No statistical outliers were identified.
- The %RSD was moderate at ~15.7%, showing some variability between laboratories (not shown in the stats table).
- The 95% confidence interval for the mean moisture result was 2.7% to 3.0%, indicating reasonable agreement overall (not shown in the stats table).
- Conclusion: The moisture results show acceptable consistency across laboratories with no outliers, though a moderate level of inter-lab variation was observed.

11.2. Quick Ash

- Results from 16 laboratories ranged between 13.4% and 14.3%, with an average of 14.0% and standard deviation of 0.27%.
- No outliers were detected.
- The %RSD of 1.96% indicates excellent precision and strong inter-laboratory consistency.
- The 95% confidence interval for the mean ash result was 13.8% to 14.1%, demonstrating a narrow and stable range.
- Conclusion: Quick ash results are statistically reliable with very good reproducibility between participants.

11.3. ISO Ash

- Results from 22 laboratories ranged from 13.1% to 13.9%, with a mean of 13.4% and standard deviation of 0.27%.
- No statistical outliers were identified.
- The %RSD was 2.03%, showing a high level of precision.
- The 95% confidence interval for the mean was 13.3% to 13.6%, suggesting tight clustering around the average.
- Conclusion: ISO Ash results demonstrate excellent agreement across laboratories with no evidence of bias or anomalies.

11.4. Volatile Matter

- Results from 27 laboratories ranged from 27.9% to 31.0%, with a mean of 29.9% and standard deviation of 0.44%.
- One outlier (Lab 66, Z = −4.49) was identified and excluded from the final analysis.
- After outlier removal, %RSD was 1.48%, showing very good reproducibility.
- The 95% confidence interval for the mean volatile matter was 29.7% to 30.1%, reflecting strong statistical consistency.
- Conclusion: Volatile matter results are precise and consistent, with only one laboratory reporting a significant deviation.

11.5. Calorific Value

- Results from 28 laboratories ranged from 27.7 MJ/kg to 29.37 MJ/kg, with an average of 28.57 MJ/kg and standard deviation of 0.46 MJ/kg.
- No outliers were identified.
- The %RSD of 1.62% indicates good inter-laboratory reproducibility.
- The 95% confidence interval for the mean was 28.37 MJ/kg to 28.77 MJ/kg, showing a narrow spread of results.
- Conclusion: Calorific value measurements are statistically consistent across all participants, showing strong agreement and no anomalous data.

11.6. Total Sulphur

- Results from 22 laboratories ranged between 0.90% and 1.14%, with a mean of 1.06% and standard deviation of 0.04%.
- One outlier (Lab 1, Z = −4.21) was detected and excluded from the dataset.
- After removal, the %RSD was 3.87%, showing moderate variability but still within acceptable limits.
- The 95% confidence interval for the mean sulphur value was 1.04% to 1.08%, confirming overall consistency.
- Conclusion: Total sulphur results are largely uniform across laboratories, with one significant low outlier excluded from analysis.