



AZURESKY PTY LTD PROFICIENCY TESTING

GENERAL ANALYSIS REPORT

Laboratory Code:

Final Report

Report No: 7

Date Issued: 01st October 2025

Document Compiled by:

Laboratory Supervisor – Tshepo Maponya

Signature:

Document Authorised by:

Managing Director - Nonhlanhla Msibi

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 B September 2025”.

The total number of participants for this round was 22.

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 Calorific Value and Volatile Matter.

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 $n \geq 10$ 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.

3. List of participants

No	Lab Name
1	Africoal SA Wilge Laboratory
2	Azuresky Pty Ltd
3	Best Enough Laboratory Services NCC
4	Best Enough Laboratory Services Springs
5	Bestech Zomhlaba Lakeside
6	Eskom Research and Testing
7	Mfulawamanzi Kleinfontein
8	Mfulawamanzi Main Laboratory
9	Mfulawamanzi Piet Retief
10	Noko Analytical Services Piet Retief
11	Ronewa Analytical Laboratory Gugulethu
12	Ronewa Analytical Laboratory Main Lab
13	Ronewa Analytical Laboratory Wescoal
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	Siza Coal Services Kinross
19	Siza Coal Services Middelburg
20	Umzamo Analytical Services Main lab
21	Umzamo Analytical Services Hendrina
22	Vitrovian Analytical Services (VAS)

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.

# Sample	Dry basis			Range (Wt)	Range sqd
	%R1	%R2	%Sample av (Xt)		
1	21,80	21,79	21,79	0,0110909	0,0001
2	21,51	21,68	21,60	0,167641	0,0281
3	21,48	21,36	21,42	0,1168126	0,0136
4	21,65	21,61	21,63	0,0458904	0,0021
5	22,11	22,22	22,16	0,1061791	0,0113
6	21,98	21,90	21,94	0,0800643	0,0064
7	21,97	22,13	22,05	0,1636029	0,0268
8	22,06	21,65	21,85	0,4021439	0,1617
9	21,68	21,83	21,76	0,145543	0,0212
10	21,66	21,79	21,73	0,1364881	0,0186
Overall Average			21,79		
Standard Deviation			0,23		
SSwithin			1,021		
SSbetween			0,0002		
$\tilde{O}$ between			0,7144		
$\tilde{o}$ pt			6,974		
Check value			2,092		

where: $\tilde{o}$ pt is the standard deviation from the pt
Conclusion : $\tilde{O}$ between < 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:

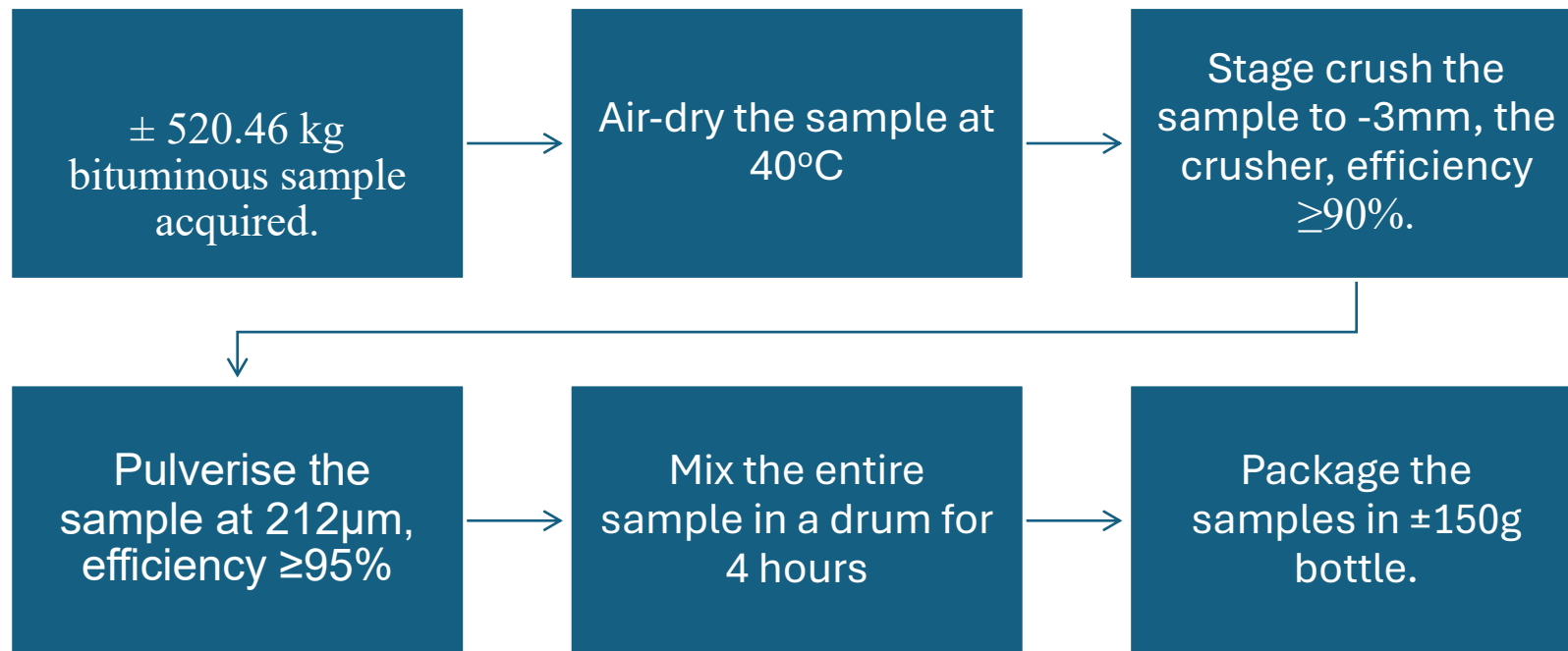
# Sample	%R1	%R2	Sample av (Xt)	Range (Wt)	Range sqd
1	21,89	22,06	21,98	0,18	0,03
2	21,91	21,97	21,94	0,06	0,00
3	21,84	21,83	21,84	0,01	0,00
4	21,88	21,87	21,87	0,01	0,00
5	21,90	21,92	21,91	0,02	0,00
6	21,93	21,74	21,84	0,19	0,04
7	21,94	21,93	21,93	0,01	0,00
8	21,83	21,84	21,83	0,01	0,00
9	21,75	21,64	21,70	0,11	0,01
10	21,77	21,72	21,74	0,05	0,00
Overall Average			21,86		
Standard Deviation			0,09		
SSwithin			0,183		
SSbetween			0,001		
Check value from the homogeneity assessment is				2,092134664	
The mean difference between homogeneity and stability assessments				0,06540817	
Since 0,07<2.09, 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

Lab ID	AIR DRY BASIS						ASH FUSION TEMPERATURE (oC)				%Hydrogen	%Total Carbon
	%Moisture	%Quick Ash	% ISO Ash	% ISO Volatile	Calorific Value MJ/Kg	%Total Sulphur	DT	ST	HT	FT		
1	1,8	21,8	***	***	25,75	0,83	***	***	***	***	***	***
2	1,5	22,4	22,3	22,4	24,2	0,75	***	***	***	***	***	***
4	1,9	21,4	21,4	23,7	25,81	***	***	***	***	***	***	***
6	1,7	21,8	21,6	24,1	25,65	0,85	1500	1500	1500	1500	***	***
19	1,9	21,6	21,6	23,5	25,51	0,80	1500	1500	1500	1500	***	65,3
25	1,7	21,9	21,7	23,9	25,79	0,81	1500	1500	1500	1500	***	***
27	1,8	21,9	***	23,9	25,49	0,88	***	***	***	***	***	***
28	1,7	***	21,7	23,6	25,59	0,86	1500	1500	1500	1500	***	***
29	1,9	21,5	***	23,8	25,10	0,79	***	***	***	***	***	***
35	2,2	21,3	***	23,8	25,42	0,85	***	***	***	***	***	***
36	2,2	21,4	***	23,2	25,57	0,83	***	***	***	***	***	***
44	1,4	21,8	***	23,8	23,66	***	***	***	***	***	***	***
46	1,9	***	21,5	23,0	25,68	0,83	***	***	***	***	***	***
49	1,7	21,8	21,7	24,8	24,80	0,76	***	***	***	***	***	***
50	1,8	21,5	21,6	23,4	23,34	0,92	1500	1500	1500	1500	***	***
65	1,8	21,5	21,5	21,9	25,70	0,82	***	***	***	***	***	***
66	1,6	21,3	21,3	24,4	25,41	0,76	***	***	***	***	***	***
68	1,8	21,6	21,6	24,7	25,65	0,94	1500	1500	1500	1500	***	***
67	1,8	21,06	***	24,12	25,31	***	***	***	***	***	***	***
69	2,3	***	21,50	23,80	25,96	0,88	***	***	***	***	***	***
70	1,7	21,00	21,70	24,00	26,14	0,83	***	***	***	***	***	***
71	2,1	21,60		23,20	26,23	0,95	***	***	***	***	***	***

	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	1,8	22,2	0,70	***	***	***	***	26,22	0,52	0,85	-0,16
2	1,5	22,7	2,41	22,6	5,63	22,7	-1,97	24,57	-1,65	0,76	-1,58
4	1,9	21,8	-0,60	21,8	-1,18	24,2	0,14	26,30	0,63	***	***
6	1,7	22,2	0,63	22,0	0,03	24,5	0,60	26,09	0,35	0,86	0,17
19	1,9	22,0	0,12	22,0	0,40	24,0	-0,21	26,00	0,24	0,82	-0,66
25	1,7	22,3	0,95	22,1	0,88	24,3	0,31	26,24	0,54	0,82	-0,52
27	1,8	22,3	1,02	***	***	24,3	0,34	25,96	0,17	0,90	0,70
28	1,7	***	***	22,1	0,88	24,0	-0,13	26,03	0,27	0,87	0,34
29	1,9	21,9	-0,20	***	***	24,3	0,23	25,58	-0,32	0,81	-0,84
35	2,2	21,8	-0,57	***	***	24,3	0,28	25,99	0,22	0,87	0,24
36	2,2	21,8	-0,46	***	***	23,7	-0,62	26,14	0,41	0,85	-0,11
44	1,4	22,1	0,41	***	***	24,1	0,05	24,00	-2,40	***	***
46	1,9	***	***	22,0	-0,11	23,4	-1,00	26,18	0,46	0,85	-0,15
49	1,7	22,2	0,61	22,1	0,93	25,2	1,60	25,22	-0,79	0,77	-1,38
50	1,8	21,9	-0,38	22,0	0,02	23,8	-0,40	23,78	-2,69	0,94	1,39
65	1,8	21,9	-0,27	21,9	-0,30	22,3	-2,61	26,17	0,45	0,84	-0,33
66	1,6	21,7	-0,93	21,7	-2,67	24,8	0,96	25,83	0,01	0,77	-1,39
68	1,8	22,0	-0,04	22,0	-0,04	25,2	1,53	26,12	0,39	0,96	1,73
67	1,8	21,4	-1,70	***	***	24,6	0,66	25,77	-0,08	***	***
69	2,3	***	***	22,0	0,30	24,4	0,38	26,57	0,98	0,90	0,78
70	1,7	21,4	-1,96	22,1	0,85	24,4	0,45	26,59	1,00	0,84	-0,18
71	2,1	22,1	0,27	***	***	23,7	-0,59	26,79	1,27	0,97	1,95
-	22	19	-	14	-	21	-	22	-	19	-
-	0	0	-	1	-	0	-	0	-	0	-
-	22	19	-	13	-	21	-	22	-	19	-
-	1,8	22,0	-	22,0	-	24,1	-	25,82	-	0,85	-
-	0,22	0,32	-	0,12	-	0,69	-	0,76	-	0,06	-

%RSD	-	-	1,44	-	0,54	-	2,86	-	2,95	-	6,92	-
Median	-	-	22,0	-	22,0	-	24,3	-	26,06	-	0,85	-
UoM	-	-	0,07		0,03		0,15		0,16		0,01	
Min	-	-	21,4	-	21,7	-	22,3	-	23,78	-	0,76	-
Max	-	-	22,7	-	22,6	-	25,2	-	26,79	-	0,97	-
standard error	-	-	0,15	-	0,06	-	0,31	-	0,34	-	0,03	-
Lower confidence limit	-	-	21,8	-	21,9	-	23,8	-	25,49	-	0,83	-
Upper confidence limit	-	-	22,1	-	22,0	-	24,4	-	26,16	-	0,88	-
Lower confidence limit 3x SE	-	-	21,5	-	21,8	-	23,2	-	24,81	-	0,77	-
Upper confidence limit 3x SE	-	-	22,4	-	22,1	-	25,0	-	26,84	-	0,94	-

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
 - ISO Ash x1, Lab ID 02; (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: Quick Ash z-scores

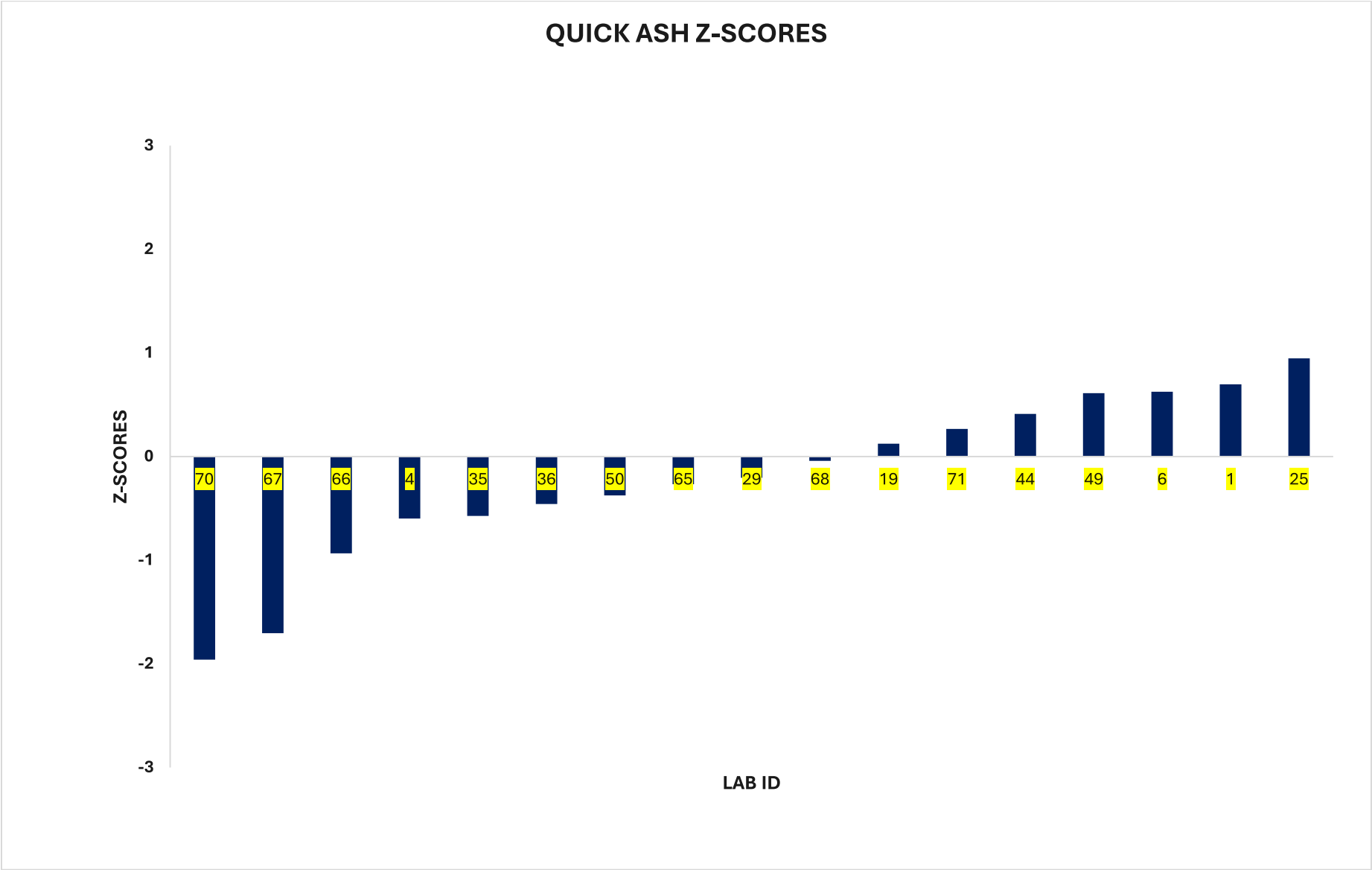


figure 2: ISO ash z-scores

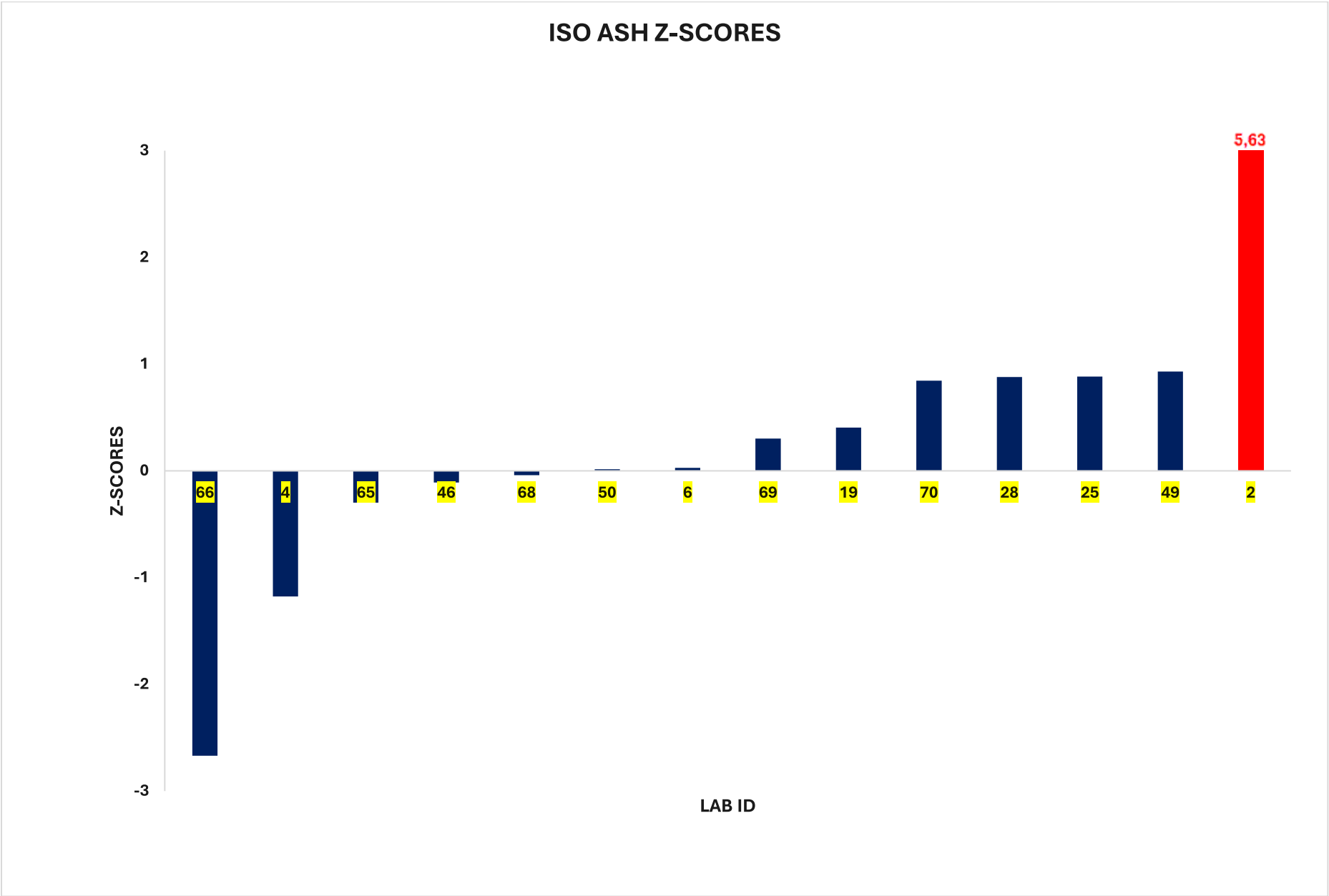


Figure 3: ISO Volatile z-scores

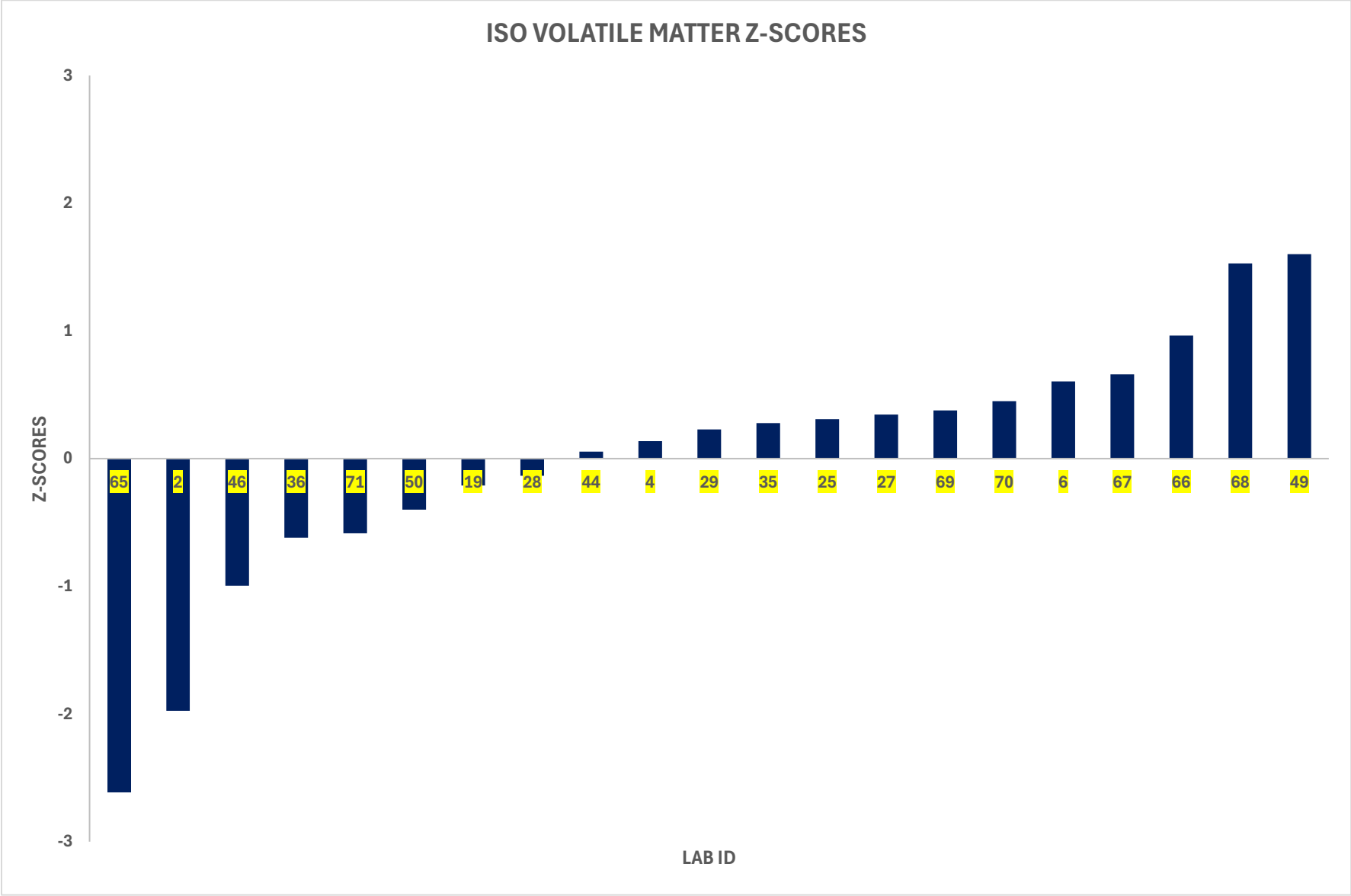


Figure 4: Calorific Value z-scores

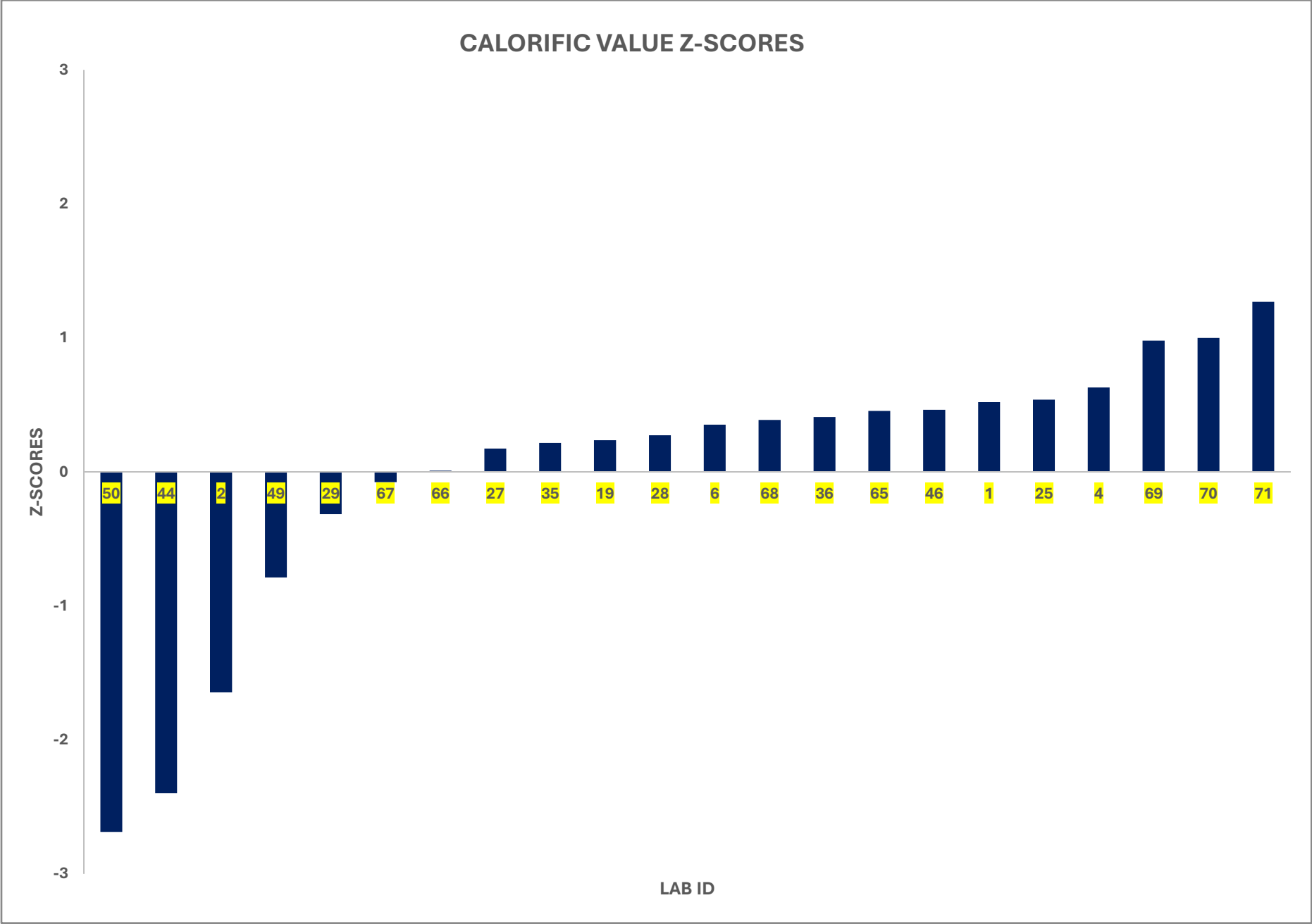
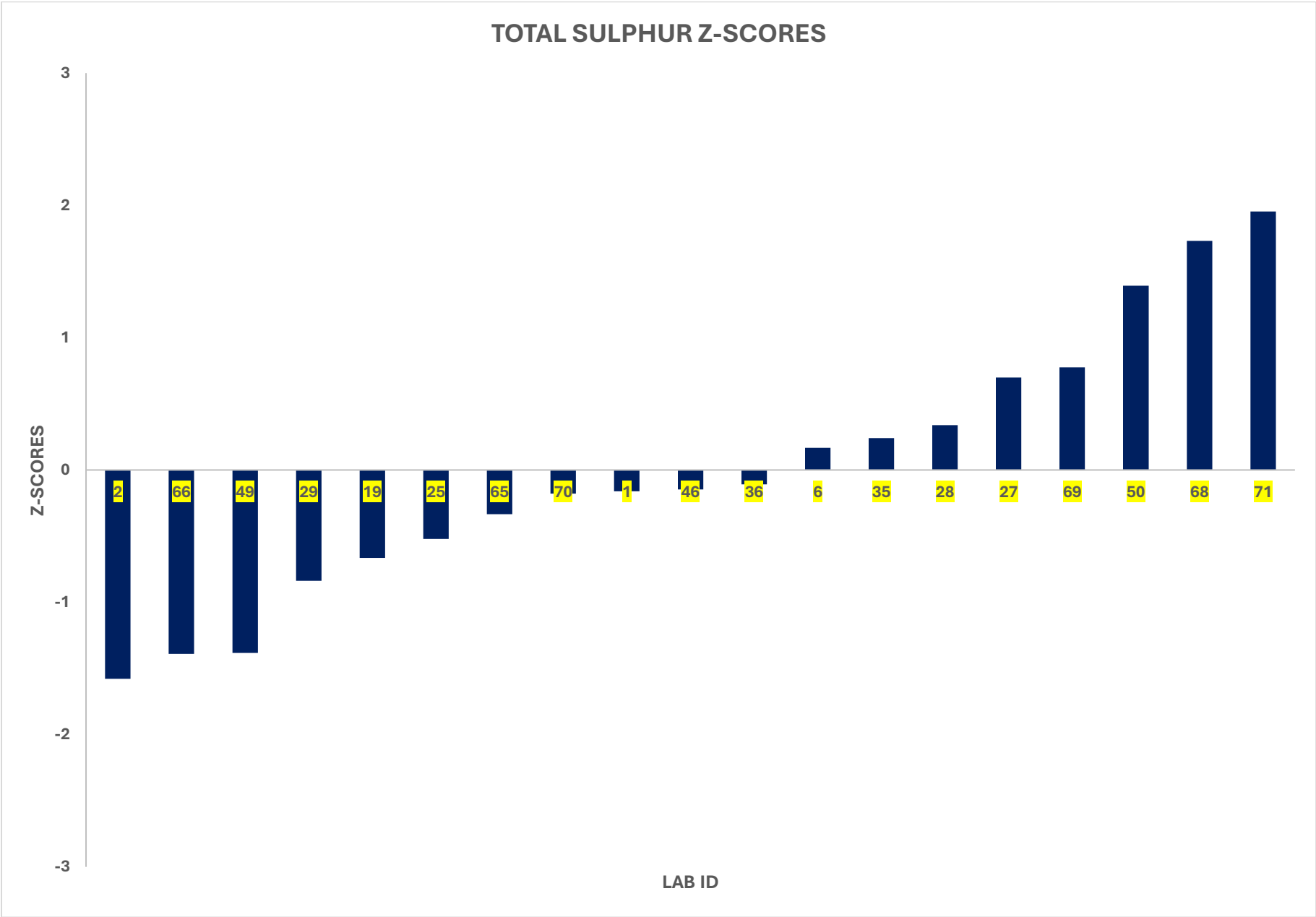


Figure 5: Total Sulphur z-scores



11. General Conclusions

11.1. ISO Moisture

- Results from 22 labs ranged from 1.4% to 2.3%, with an overall mean of 1.8% and a standard deviation of 0.22%.
 - The dataset showed no statistical outliers.
 - Relative standard deviation (%RSD) was 11.91%, indicating moderate between-laboratory variation.
 - The 95% confidence interval (CI) for the mean moisture is 1.7% to 1.9%, showing most results clustered closely around the mean.
 - Conclusion: Moisture results are statistically consistent across participants, with no extreme deviations.
-

11.2. Quick Ash

- Results from 22 labs ranged from 21.4% to 22.7%, with an overall mean of 22.0% and standard deviation of 0.32%.
 - No statistical outliers were identified.
 - Precision was good, with a %RSD of 1.44%, reflecting close agreement between laboratories.
 - The 95% CI for the mean ash is 21.8% to 22.1%, confirming reliable comparability.
 - Conclusion: Quick Ash results show excellent reproducibility, with strong inter-laboratory consistency and no signs of systematic bias.
-

11.3. ISO Ash

- Results from 14 labs ranged from 21.7% to 22.6%, with an overall mean of 22.0% and standard deviation of 0.12%.
 - One outlier was flagged and removed, leaving 13 valid participants.
 - Precision was very strong, with a %RSD of only 0.54%.
 - The 95% CI for the mean ISO ash is 21.9% to 22.0%, indicating tight agreement across labs.
 - Conclusion: ISO Ash values are statistically robust, with very high reproducibility and minimal variation between laboratories.
-

11.4. Volatile Matter

- Results from 21 labs ranged from 22.3% to 25.2%, with an overall mean of 24.1% and a standard deviation of 0.69%.
- No statistical outliers were detected.
- Precision was moderate, with a %RSD of 2.86%
- The 95% CI for the mean volatile matter is 23.8% to 24.4%, narrowing the true consensus value.
- Conclusion: Volatile matter results show moderate inter-laboratory variability but remain statistically consistent, with no extreme deviations.

11.5. Calorific Value

- Results from 22 labs ranged from 23.78 MJ/kg to 26.79 MJ/kg, with a mean of 25.82 MJ/kg and standard deviation of 0.76 MJ/kg.
- No outliers were identified.
- Variability was modest, with a %RSD of 2.95%.
- The 95% CI for the mean calorific value is 25.49 MJ/kg to 26.16 MJ/kg, showing relatively tight agreement.
- Conclusion: Calorific value determinations are statistically reliable, though a small number of labs showed results lower than the consensus. Overall comparability remains acceptable.

11.6. Total Sulphur

- Results from 19 labs ranged from 0.76% to 0.97%, with a mean of 0.85% and standard deviation of 0.06%.
- No statistical outliers were found.
- Variability was somewhat higher relative to the mean, with a %RSD of 6.92%.
- The 95% CI for the mean sulphur content is 0.83% to 0.88%, suggesting consistent reporting.
- Conclusion: Total sulphur results are broadly consistent across participants, though with slightly higher relative variation.