QOTHO PROFICIENCY TESTING SCHEME GUIDELINES

QM-GUI-003

a SANAS Accredited Proficiency Testing Scheme Provider, No. PTS0012

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1 Overview:

1.1 Mission Statement:

Creating value for all our stakeholders by channeling resources to provide matrix-matches certified reference materials and proficiency testing programs, that contribute to improving the minerals industry.

1.2 About the Company:

Qotho Minerals specifically focuses on the design and implementation of Proficiency Testing Schemes (PTS), as well as the manufacturing and certification of Reference Materials. All our PT programs are pre-planned and paid-for programs, unless a special PT is arranged, to certify a commodity that is not currently in the Qotho PT Schedule.

Since its inception in 2013, Qotho has annually been introducing more PT Scheme within the mining industry. Participation in our schemes affords each laboratory the unique opportunity to assess the accuracy and comparability of their results with peer laboratories over time. Through the scheme, QRM's are generated, which provides an invaluable tool for further internal monitoring and instrument calibration.

Qotho Minerals is accredited to ISO/IEC 17043: 2023 as a PT Provider and to ISO 17034: 2016, as a mineral CRM Producer.

All the Qotho PT schemes are published on the EPTIS database. Kindly inform your international referee labs and marketing teams - the direct link is https://www.eptis.bam.de/eptis/WebSearch/view/432591.

1.3 Proficiency Testing Schemes

1.3.1 ISO/IEC 17043: 2023 defines proficiency testing as an evaluation of participant performance against pre-established criteria by means of interlaboratory comparisons.

1.3.2 Proficiency testing schemes entail the organization, development and evaluation of tests (of the same item or similar items) by several laboratories, according to predefined conditions.

1.3.3 It is a requirement of ISO/IEC 17025: 2017, that Laboratories participate in inter-comparisons programs and/or PT schemes.

1.3.4 In addition, any laboratory that needs to demonstrate the quality of its analytical results in an independent way should participate in proficiency testing schemes, since the quality of the analytical results is directly linked to the quality of service / product, to the market credibility and brand image.

1.3.5 Participation in Proficiency Testing Schemes is an essential tool to demonstrate the technical competence of the laboratory, and it allows to:

1.3.5.1 Compare own results with those obtained by other laboratories.
1.3.5.2 Confirm the correct initial validation of a method.
1.3.5.3 Use the data obtained from participation in Proficiency Testing Schemes for validation of measurement methods.
1.3.5.4 Determine systematic errors.
1.3.5.5 Improve the test method used.
1.3.5.6 Learn from the methods used by other laboratories.
1.3.5.7 Monitor the accuracy and precision of the method.
1.3.5.8 Encourage collaboration between laboratories.
1.3.5.9 Demonstrate technical competence against third parties.

1.4 Why choose Qotho as your Proficiency Test Provider?

1.4.1 We are an independent service provider, therefore no opportunity exists for biased interpretation of results, as may be the case through in-house operated schemes.

1.4.2 We provide standardized method preparation of testing samples in accordance with ISO standards.

1.4.3 Participation in the Qotho-run PTS provides a structured, annual PT framework and eliminates the need for laboratories to plan, organize and execute internal PTS.

1.4.4 The PTS samples are typical of those tested by laboratories on a daily basis, thereby replicating the daily testing work performed by the laboratory on samples received from customers.

1.4.5 Access to all general benefits that regular participation in PTS brings, including presentations and providing technical feedback on your laboratory's unique performance.

2 Quality Standards

Qotho PT schemes complies with the requirements of the following international standards:

2.1 ISO/IEC 17043: 2023 – Conformity assessment – General requirements for proficiency testing.

2.2 ISO/IEC 13528: 2022 – Statistical methods for use in proficiency testing by inter-laboratory comparisons.

2.3 ISO/IEC 17034: 2016 - General requirements for the competence of reference material producers.

2.4 ISO/IEC 17025: 2017 - General requirements for the competence of testing and calibration laboratories.

2.5 ISO 33405: 2024 - Reference materials — Approaches for characterization and assessment of homogeneity and stability.

2.6 IUPAC International Harmonized Protocol for the proficiency testing of analytical chemistry laboratories.

2.7 Samples are prepared according to the ISO or other international standard & guidelines (e.g. ASTM, BSI etc.) for preparation of the particular commodity.

2.8 Uhlig, Steffen. Journal of Consumer Protection and Food Safety (2015) 10:385–391 - Robust estimation of between and within laboratory standard deviation with measurement results below the detection limit.

3 Scheme Framework

3.1 Coordination and Responsibilities

3.1.1 Responsibility and coordination of the schemes lies with Qotho Minerals.

3.1.2 The PT Scheme Manager is responsible for the routine operations, monitoring & control of any subcontractors that may be used in the execution of the scheme.

3.1.3 All practices and procedures are documented in our internal Quality System.

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Contact Persons:

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PT Administration **O:** [+27] (0)87 004 3200	All PT Scheme Administration Email: admin@qotho.co.za	All General PT enquiries / Appeals / Complaints & Comments / PT Administration/ PT Registrations / Survey Feedback / Marketing
Results reporting	results@qotho.co.za	Dedicated Results email
Sample delivery confirmation emails	logistics@qotho.co.za	Sample Tracking / Sample receipt

3.2 Advisors & Advisory Committee

3.2.1 The technical and statistical expertise of advisors may be utilised from time to time. Where the inputs of an advisor have been used for a specific scheme or round, this will be communicated in the final report of that particular round.

3.2.2 An Advisory Committee, consisting of members who may or may not be participants of any particular scheme, but who have expertise on the particular commodity, is responsible for the overall direction of the scheme. The Committee will include a statistics expert. Whilst this committee does not meet, the individual members are available, to assist, where and when required.

3.3 Type of Schemes & Participation

3.3.1 All the schemes operated by Qotho Minerals can be classed as quantitative, simultaneous schemes, where the assigned values of the test items are determined only once results have been returned by all the participants, and participants are then assessed on the difference between their result and the assigned value.

3.3.2 The schemes are of a “closed” nature meaning they have a defined start and completion date. Qotho runs multiple rounds annually. All PT rounds run independent of one another.

3.3.3 The published Qotho PTS are open to all laboratories that which to prove or develop their competence in a particular field. Other than having to pay to participate, we do not specify minimum criteria, for participation.

3.3.4 Qotho can also offer bespoke PT schemes to clients, if the current Qotho programs or evaluation frameworks do not meet the minimum requirements set for themselves, by such client. These are designed on a case-by-case basis, but aims to meet the minimum requirements, as per the accredited Qotho Minerals PT protocol. Please contact the Scheme Director, should you wish to run your own, closed, PT Scheme.

3.4 Subcontractors

3.4.1 Various aspects of the PTS can, from time to time, be subcontracted.

3.4.2 Qotho Minerals maintains a list of approved sub-contractors.

3.4.3 Where homogeneity analysis is outsourced, this is done via an ISO/IEC 17025 accredited facility, or one for which Qotho Minerals could prove competence, based on recent performances within the relevant PTS.

3.4.4 Where any work within a specific PT round was subcontracted, this will be clearly indicated within the PT report.

3.5 Events Calendar

3.5.1 The PTS events calendar is published annually, before the end of the third quarter, for the following calendar year.

3.5.2 All the programmes offered for the calendar year is listed, together with the date of sample dispatch, result reporting deadline, and report publication deadline.

3.5.3 Participants can therefore plan their PT participation well in advance, thus ensuring their compliance to ISO/IEC 17025: 2017.

3.6 Scheme Flow

3.6.1 A minimum of 7 participants is required for a scheme to be initiated.

3.6.2 Participants' orders are processed and confirmed.

3.6.3 Procurement/sourcing, preparation, packaging and Quality Control of test items.

3.6.4 Test items dispatched to participants.

3.6.5 Participants test the items and report the results and methodology used to Qotho, as instructed and within the agreed timeframe.

3.6.6 Results analysed, and performance of laboratories assessed, using appropriate statistical techniques.

3.6.7 Reports written and issued to participants.

3.6.8 Round reviewed and requirements identified, for future rounds.

3.6.9 Commencement of next round.

3.7 Joining the Scheme & Scheme Costs

3.7.1 All the currently available schemes, with details relating to types of samples and frequency, can be found on the Qotho website www.qotho.co.za

3.7.2 An application form for the various Schemes is available. This must be completed and submitted to Qotho for processing. Based on the individual laboratory's requirements, Qotho will accordingly prepare a quotation for the client. No applications will be processed without an official order number or upfront payment.

3.7.3 Participants will be invoiced, pro-rata, on an annual basis (Calendar year), for the schemes and rounds that they choose to partake in. Alternatively, invoicing is done after the completion of each round.

3.8 Confidentiality

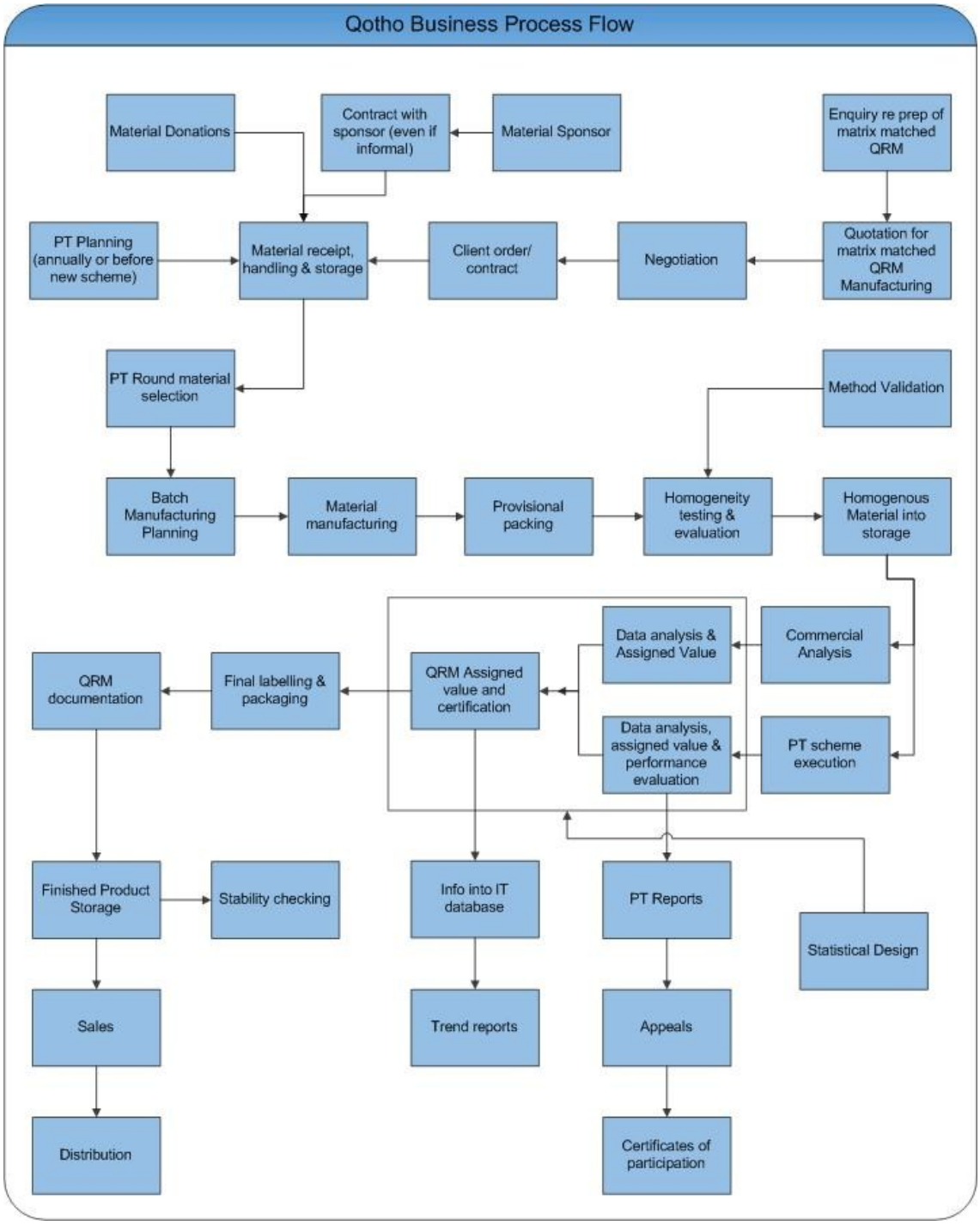
3.8.1 In order to ensure confidentiality, participants in the scheme are allocated a unique reference code.

3.8.2 This approach enables results to be reported without linking the results to any particular laboratory.

3.8.3 Each laboratory will know their unique code and is therefore able to extract their own data from the report.

3.8.4 A general list of the participating laboratories to each scheme will reflect on each round being reported.

3.9 PT and QRM Flow Chart:



4 PT Execution

4.1 Sample Selection

4.1.1 Participants in the scheme will be offered the opportunity to supply the testing material for a round. This will enable participants to obtain scheme data on their own matrix and material type. Please contact the Operations Manager to obtain details of quantities required, etc. All costs related with the supply and delivery of the material to our offices in Broederstroom, will be for the particular participants' account.

4.1.2 If participants do not volunteer material, it will be sourced by Qotho, at its own discretion – whilst still ensuring that the material meets the requirements and specifications of the relevant Scheme.

4.2 Preparation & Homogeneity

4.2.1 Where relevant, samples are prepared according to the ISO standard for the preparation of the particular commodity (crush, dry, mill, screen).

4.2.2 Blended samples are divided by means of a rotary splitter, until the desired subsample size is reached.

4.2.3 Homogeneity tests will then be conducted, as per the criteria of the Harmonized Protocol for Proficiency Testing of Analytical Chemistry Laboratories, ISO 13528 as well as ISO 33405.

4.2.4 If the samples pass the homogeneity test, they may be used in a PT round.

4.2.5 If homogeneity is not achieved, the entire batch will be re-processed, until homogeneity is achieved.

4.3 Delivery and Retention

4.3.1 Appropriately packaged samples are dispatched to participants.

4.3.2 On the day of dispatch, the Instruction Letter and Reporting Template for the round, are e-mailed to all the registered participants.

4.3.3 It is the responsibility of the participants to read and comply with the emailed instructions.

4.3.4 Once packages are delivered, the onus to maintain the integrity and stability of the material, transfers to the recipient thereof.

4.3.5 Participants are requested to check the contents of the packaging upon receipt and to contact Qotho, should they consider that the integrity of the material has been jeopardised.

4.3.6 The participant must retain the sample for that particular round until the final report from Qotho is issued for that round (this will enable them to investigate any non-conformances they might get).

4.3.7 On completion of the PT Round (once report is deemed final), participants can dispose of the samples, as per their internal sample disposal protocol.

4.4 Reporting of Results

4.4.1 In order to enable reports to be processed and issued as soon as possible after the closure of the test round, deadlines for the return of results are specified and must be adhered to. Refer to QM-GUI-004 Events Calendar, that is published on the Qotho webpage.

4.4.2 Results received after the reporting deadline cannot be included in the report. The report is however available to all participants subscribing to the scheme, regardless of whether their results were submitted or not.

4.5 Choice of Analytical Methods to be used

4.5.1 Unless otherwise instructed, participants may use any test method that they believe technically appropriate.

4.5.2 Participants are asked to treat the test material in the same way as they would a routine sample (unless instructed to do otherwise, in the Instruction letter).

4.5.3 The procedures used, must be stated when reporting the results.

4.6 Reporting Format

4.6.1 Unless otherwise instructed, results shall be reported in Excel format using the template provided by QM.

4.6.2 It is recommended that results and calculations are checked thoroughly before reporting.

4.6.3 The results should be reported clearly, in the format and units detailed in the scheme description.

4.6.4 If calculations are used, only the final result must be reported.

4.6.5 In general, results of 0 should not be reported – results should rather be reported as less than the determination limit of the procedure used.

4.6.6 Where participants use CRM's as part of their analysis protocol, it is requested that the results of such CRM's analysed with the sample, be reported as well (This information assists with the confirmation of metrological traceability, should the material qualify to be certified).

4.6.7 Results are reported as received, but where more than 3 decimal figures were reported, rounding may be done by Qotho.

4.6.8 Although not compulsory, participants are also required to specify the methods used for digestion/preparation as well as analysis of the samples.

4.7 Number of Results

4.7.1 Each participant must report two results per analyte (duplicate) per method, or as determined in the Letter of Instructions to Participant, which is dispatched with every round. Each participating laboratory submits two results per analyte, per method used.

4.7.2 Where results from multiple analysts are used to derive the final number that is submitted QM, participants need to ensure that only statistically sound data processing methods are utilised.

4.7.3 If a laboratory uses two distinctly different procedures, with similar or different metrological traceability, they may report a set of results for each method. Each set of results are then treated as an independent set.

4.8 Turn Around Times

4.8.1 All assay results must be reported to Qotho by the reporting deadline. We aim to provide Laboratories 3 weeks to complete the analysis and report results.

4.9 Collusion and Falsification of Results

4.9.1 Not returning genuine results, defeats the objective of participating in a proficiency scheme.

4.9.2 Certain measures are built into the scheme to try and prevent collusion.

4.9.3 Participants will be contacted directly, if collusion is expected.

4.9.4 The responsibility, however, ultimately lies with each participant, to operate and conduct themselves in a professional manner.

4.9.5 Proficiency testing samples may not be outsourced or subcontracted to external laboratories.

4.10 Report Format

4.10.1 Reports will be distributed electronically (pdf format) to all participants in the scheme. It will include details of the material tested, its composition, its assigned value, the method of evaluation applied, as well as graphic and tabular representation of participants' (participant codes, not actual names) results and performance. Where appropriate, comparative analysis of the various techniques used, per analyte, will also be included.

4.11 Complaints, Advice and Feedback

4.11.1 Through continuous communication and feedback, Qotho Minerals welcomes the comments of participants to the scheme. These can be forwarded to admin@qotho.co.za. Our Complaints and Appeals Form QM-FQC-012 can also be used for this purpose and is available upon request.

4.11.2 An appeals period of 7 days is allowed. If no appeals are received, the report is then deemed to be final. No appeals will be considered after the appeals period.

4.11.3 All appeals will be investigated and where justified, Qotho will make the necessary corrections to the evaluation and re-issue the report. No amendments to reports will be done, as a result of transcription errors by participants.

4.11.4 Where possible, practical and relevant, the necessary improvements will be incorporated into future rounds.

5 Data Processing & Statistical Evaluation (Non-operationally defined)

As has been the case since inception, all statistical calculations and performance evaluations have to date been non-operationally defined. This means that no distinction has been made between either method of digestion, analysis or detection, when the statistical parameters of the dataset were calculated (prior to participant evaluation). This non-operationally defined protocol will remain in place, but as of Round 4 2025, operationally defined statistics and evaluations will be added to the various PT programs, as and where deemed appropriate. Please refer to section 6, for more details

5.1 Evaluation Criteria

5.1.1 The factors affecting the statistical calculations for performance scoring are not effective if there are:

5.1.1.1 Fewer than 5 data sets per analyte.

5.1.1.2 The analytes under evaluation are affected by issues of homogeneity and inhomogeneity.

5.1.1.3 Other factors that may be raised by the scheme administrator which will be communicated, eg a bi-modal dataset.

5.1.2 In such circumstances, there may be an increased uncertainty of the assigned value; hence no evaluation will be done on the affected analyte/s or sample/s. This will be clearly highlighted in the PT reports, with (*) where relevant.

5.2 Results below the limit of detection

5.2.1 If 50 % or less of the reported results for a particular analyte is below the detection limit, a value of half the detection limit is assigned to the particular results. (Ref to Uhlig, S.)

5.2.2 If more than 50% of the results are reported as below detection limit, then the data is not evaluated.

5.2.3 Should the application of this rule render a multi-modal dataset (based on Kernel Density graphs), then the results will not be evaluated.

5.2.4 Should a participant be negatively impacted by this rule, their result will not be evaluated, and this will be clearly highlighted within the report.

5.3 Results above the detection limit.

5.3.1 Greater than results are deselected from the dataset, for the calculation of the assigned values and standard deviation of proficiency assessment (SDPA), after which it is returned to the dataset. These values are however not evaluated.

5.4 Assigning of values

5.4.1 In the Qotho PT Scheme, the consensus means and the SDPA are estimated with the Q/Hampel method, a robust method recommended in the ISO 13528 standard. The statistical evaluation of the results is performed using validated PROLab Plus software.

5.4.2 In the first calculation step the SDPA is estimated by applying the Q method, in the process ensuring that any present outliers in the submitted results are identified and empirically softened therefore reducing the influence of these outliers on the robust mean. The robust standard deviation is then used to calculate the mean value applying the robust Hampel estimator. The robust mean and robust standard deviation characterize to some extent the overall competence of the laboratories and are used to derive z-scores. The z-scores represent a measure of how far a result is from the (consensus) assigned value. For quantitative data, the uncertainty of the assigned value is also calculated.

5.4.3 The uncertainty (U_x) of the assigned value (X) is calculated as follows (done in PROLab):

$$U_x = 1.25 \times \frac{\sigma_{pt}}{\sqrt{p}},$$

Where σ_{pt} is the robust standard deviation of the results and p is the number of data sets.

5.4.4 PT reports will reflect assigned values and uncertainty, expanded with a coverage factor of 2.

5.4.5 The uncertainty of the assigned value is assumed to include the effects of uncertainty in homogeneity, transport, instability and laboratory measurement uncertainty.

5.5 Z-score

5.5.1 The evaluation method (general rule) is via the z-score calculation, which is as follows:

$$z\ score = \frac{x - X}{\sigma_{pt}}$$

Where x = Participants result.
X = Assigned value – derived by using the Hampel-estimator
σ_{pt} = Standard deviation for proficiency assessment (SPDA)

5.6 Z-prime score

5.6.1 The z' score is calculated using the following formula:

$$z'\ score = \frac{(x - X)}{\sqrt{\sigma_{pt}^2 + U_x^2}}$$

Where x = Participants result.
X = Assigned value – derived by using the Hampel-estimator
σ_{pt} = Standard deviation for proficiency assessment (SPDA)
U_x = Uncertainty of the assigned value

5.6.2 However, if the uncertainty of the assigned value is greater than 0.3 x SDPA, the corresponding effect on the participants' performance scores cannot be considered to be negligible. In this situation, a comparison between the z-score and z'-score (z prime) evaluations will be carried out to consider the effects of a participants' scores when the uncertainty of the assigned value has been included in the interpretation of the results. If there are significant differences between the two evaluation methods, the negatively impacted participants will not be evaluated. This will be clearly communicated within the report. If there are no differences, all the datapoints will be evaluated by the z-score.

5.6.3 If the uncertainty of the assigned value is greater than 0.3 x SDPA for most analytes in a particular sample, the PT Scheme Director may make a determination for all the evaluations for that sample to be done via z'-scores, rather than z-scores. This will however be evaluated on a case-by-case basis and clearly documented on the evaluation checklists and within the PT report.

5.7 Irrespective of which of the above scoring mechanisms are used, the basic performance categories and reporting formats to be used are as follows:

Score	Interpretation	Colour coding
|z or z'| ≤ 2.00	Satisfactory results	No colour
2.00 < |z' or z'| < 3.00	Questionable results	Amber
|z or z'| ≥ 3.00	Unsatisfactory results	Red
No score given	No result reported	Blank cell.

5.8 For bespoke PT programs, additional evaluation tools such as En-scores and J-scores will be considered, based on the clients' specific requirements.

6 Data Processing & Statistical Evaluation (operationally defined)

Dependent on the dataset in hand, the PT Scheme Management may opt to conduct Operationally defined evaluations. These operationally defined evaluations would involve extracting data generated by specific digestion methods or analytical methods, from the dataset, and to calculate new statistical parameters and do additional evaluations, based on the data from these parameters only. Examples of such operationally defined sub-sets could include:

- Samples analysed via total sample digestion (eg 4-acid and fusion)
- Samples processed via fused bead XRF
- Main commodity analysed by industry recognized methodologies (ISO, ASTM etc.)
- Copper metal impurities – evaluation of the Spark OES subset

Once the sub-set has been selected, the exact same criteria and methodologies as described in 5.1 - 5.7, is followed, and evaluations will only be done, where all the criteria are met.

7 Reference Materials

7.1 On completion of a round, analytical values will be assigned to the particular samples, based on the results of the PT round. A list of all the material available and their assigned values, will be made available to participants, upon request. This material will be on sale to laboratories, for use as Reference Materials. The reference materials will be available to the sponsor of the material, at a significantly discounted rate. Once adequate data is available, certification of the material will be done by Qotho, after which a COA will be issued.

8 Document Approval

This document was re-approved on 16 May 2025:

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This document has been electronically signed using an Advanced Electronic Signature (AES) in terms of the Electronic Communications and Transactions Act No. 15, 2002 (ECT Act). Any amendments to the document can be detected by reference to the Signature Panel displayed in the electronic pdf version of the document.

9 Document Amendments

9.1 Table of content amended to add non-operationally defined and operationally defined.

9.2 All reference to ISO/IEC 17043: 2010 has been amended to ISO/IEC 17043: 2023.

9.3 Point 2 – 2.5 - ISO 33405: 2024 reference added.

9.4 Contact Persons amended

9.5 Point 4.2.3 – Amended

9.6 Point 4.3.2 & 4.3.6 – Amended

9.7 Point 4.3.7 – Added

9.8 Section 5 – Heading and Description Amended

9.9 Section 6 - Heading and Description Amended