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Copper, lead, zinc and nickel concentrates — Guidelines for the inspection of mechanical sampling systems

Concentrés de cuivre, de plomb, de zinc et de nickel — Lignes directrices pour le contrôle des systèmes mécaniques d'échantillonnage

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11790 was prepared by Technical Committee ISO/TC 183, *Copper, lead, zinc and nickel ores and concentrates*.

Copper, lead, zinc and nickel concentrates — Guidelines for the inspection of mechanical sampling systems

WARNING — This International Standard may involve hazardous materials, operations and equipment. It is the responsibility of the user of this International Standard to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard sets out recommended practices for the inspection of mechanical sampling systems. It serves as a reference for conformance with applicable International Standards for copper, lead, zinc and nickel concentrates.

This International Standard covers general considerations, including precision, quality variation, bias, establishment of inspection systems and inspection procedures.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12743, *Copper, lead, zinc and nickel concentrates — Sampling procedures for determination of metal and moisture content*

ISO 12744, *Copper, lead, zinc and nickel concentrates — Experimental methods for checking the precision of sampling*

ISO 13292, *Copper, lead, zinc and nickel concentrates — Experimental methods for checking the bias of sampling*

ISO 20212, *Copper, lead, zinc and nickel sulfides — Sampling procedures for ores and smelter residues*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12743, ISO 12744, ISO 13292 and ISO 20212 and the following apply.

3.1
audit
critical review of a mechanical sampling system, undertaken by a suitably qualified person not directly involved in the operation of that system, which measures its compliance with stipulated operating specifications

3.2
mechanical inspection
comparative record of observations and measurements of physical parameters against design criteria, and records of subsequent changes or improvements undertaken by a suitably qualified person not involved in the day-to-day operation of the system

3.3
operational inspection
record of observations and inspections undertaken by the system operator before, during and after the sampling of a lot

NOTE The operator is the person taking the sample.

4 General consideration

4.1 Precision

Precision checks are recommended for each material type sampled by the system. If there is a significant change in material type or a new material type is introduced, a precision check should be carried out. The test should outline the precision of sampling, preparation and analysis of each material type sampled by the system. These tests are to be in accordance with ISO 12744.

4.2 Quality variation

The variance between increments, s_b^2, is a measure of the heterogeneity of the lot and is the variance of the quality characteristics of increments taken from the lot. The value of s_b^2 shall be measured experimentally for each material type for each handling plant under normal operating conditions, in accordance with ISO 12743 and ISO 20212.

The entire material-handling system up to the mechanical sampling system should be examined to determine whether any unloading, storage, or reclaiming procedures produce a cyclical pattern which could cause the increment collection to get in phase with the sequence of material variability. Variations in the physical characteristics, such as particle-size distribution, surface moisture, extraneous matter and oversized material, could become cyclical and could even be in phase with mass-based or time-based increment collection. Where such cyclical variations occur in the material stream, the source of the variations should be investigated to determine the practicability of eliminating the variations. If there is no practical way to eliminate the variations, the interval between primary cuts should be adjusted so that the collection of increments is not in phase with the cyclic variation. Alternatively, stratified random sampling may be used.

4.3 Bias

After commissioning and auditing of a new system or any major engineering modifications of an existing system, a bias test should be carried out in accordance with ISO 13292 to confirm the correct operation of the system. In multi-material-type facilities, it is recommended that the material having the highest variability be chosen for the bias test.

It is recommended that, on a regular basis, further bias sample pairs be taken to confirm that the initial bias result is still relevant. If a significant change is made to the sampling system, or a new material having more difficult sampling characteristics is introduced, the need for a new bias test should be considered.

NOTE Provided that the mechanical sampling system satisfies the criteria outlined in ISO 12743 and ISO 20212, bias tests are not mandatory. However, quality-assurance principles at individual plants might require bias tests.

4.4 Operation of the sampling system

The mechanical sampling system should be started at some time in advance of the start of conveying the material to be sampled, so that any foreign substances (including water) are purged. Where hydraulic drives are used, sufficient time should be allowed for the hydraulic oil and the associated system to attain temperature equilibrium. It is recommended, particularly in multi-material-type sampling systems, that one primary cut be allowed to pass through the mechanical system as a conditioner before sampling commences.

It is recommended that the operator review any sampling-system records maintained by the previous operator. These records should include such things as quantities of material handled and sampled, and notations as to system malfunctions, stoppages, blockages, or other deficiencies. The operator should use a suitable checklist, such as the example in Annex A. It is recommended that the operator complete all items on a suitable checklist designed for the particular system. For large multi-user systems, an operator's inspection report, such as the example in Annex B, should be developed.

Sufficient suitably designed inspection points should be available to observe that the falling-stream and cross-belt cutters cut the full stream of material, and cutter apertures can be inspected for blockages and blinding.

5 Establishment of inspection system

5.1 General

To ensure reliable operation, it is recommended that a sampling checklist (Annex A) and operator's sampling record (Annex B) be developed with input from the following sources:

a) original design criteria and records of any subsequent changes or improvements;

b) sampling equipment operating and maintenance manuals;

c) management responsible for the system;

d) personnel operating or maintaining the system;

e) for a new system, the designers and commissioning personnel.

The general method for establishing these procedures is as follows.

1) Refer to ISO 12743 and ISO 20212 to ascertain the correct sampling scheme.

2) Refer to the equipment supplier's operating and maintenance manuals to ascertain correct procedures for operation and intervals for routine maintenance. The manuals can provide useful information on the basis of the system design. Information such as conveyor rates, conveyor speeds and material parameters (particularly sizing and variability) are significant data and should always be kept in mind when changes are contemplated.

3) Examine existing sampling and maintenance records for an extended period. This information will provide guidance for operators to ensure that the required level of inspection and maintenance is carried out to ensure reliable operation, and will possibly alert operators to any inappropriate maintenance or modifications that may have been made to the equipment.

4) Seek the personal experience of maintenance, operational and sampling personnel with respect to the sampling system. This information, together with that obtained from the above, will enable an appropriate operator's manual, operator's sampling record and system checklist to be prepared.

5.2 Audits

A scheme for regular audits of the sampling system should be established. Reference should be made to the original operating parameters and equipment supplier's design data, as well as any records of any subsequent changes or improvements, in order to establish conformance with current applicable International Standards. Annex A provides a typical reference list.

NOTE 1 Correct operation of all new systems needs to be confirmed by an audit following the commissioning stage before being accepted as operational.

NOTE 2 The design and operation of the system need to be confirmed by an audit prior to any bias test.

5.3 Mechanical inspections

A scheme for routine inspections of the sampling system by operators should be established, similar to the example in Annex A. The frequency and detail of inspections will be determined by factors such as, but not limited to, reliability of the system, handling characteristics of the sampled material, frequency of use of the system and purpose of sampling (e.g. process control compared to large multi-user port facilities).

5.4 Operational inspections

Operational procedures and inspections should be established and carried out immediately before, during and immediately after operation of the sampling system for a given lot or sub-lot, similar to the example in Annex A. These procedures and inspections will be less extensive than those undertaken as audits or mechanical inspections, as given in 5.2 and 5.3, respectively. They should be designed to be simple inspections of the integrity of the sampling process. For large multi-user facilities, it is recommended that a system of operational reports be developed and an example of such a report is provided in Annex B.

6 Procedures

6.1 Audits

When assessing the conformance of a mechanical sampling system, an auditor should refer to Annex A, the relevant parts of ISO 12743 or ISO 20212, and the design flow chart of the particular system being evaluated. It is recommended that an audit be carried out at least once per year by a suitably qualified person who is not directly involved in the operation and management of that particular sampling system.

It is essential that reference be made to the original operational parameters upon which the sampling system was designed, as well as records of any changes or improvements. Operational conditions, such as conveyor capacity, belt speed or material top size, could have been altered without due regard to the impact on the operation and conformity of the sampling system.

Common examples of such alterations and their potential consequences are as follows.

a) An increase in the capacity of a conveyor could result in an excessive primary increment mass that will no longer be entirely contained by the primary sample cutter.

b) A change in conveyor speed could affect the trajectory of material at a transfer point which could result in a part of the material stream being missed by the sample cutter.

c) A change in nominal top size of the concentrate/ore could result in the original cutter aperture no longer being large enough (i.e. three times the nominal top size of the material being sampled) to conform to ISO 12743 or ISO 20212.

Items that should be covered as a minimum are as follows.

1) Safety requirements of site.

2) Original and current operating parameters.

3) Selection of appropriate sampling procedure.

4) General condition of the equipment, including build-up of material or blockages in chutes, cutters and sample loss or sample contamination.

5) Comparison of design and actual increment masses for all cutters at several flow rates on the product belt, up to the maximum.

6) Condition of cutters, cutter apertures and cutter lips. Check for foreign material, such as wood, rags, stones and material that may be blinding the cutter apertures.

7) Conformance to ISO 12743 and/or ISO 20212, in particular:

   i) minimizing bias;

   ii) correct design and operation of sample cutters;

   iii) the number of primary increments and sub-lots required;

   iv) the methods of taking primary increments and division of gross samples, partial samples and increments.

8) Ongoing precision monitoring using ISO 12744.

9) Crusher condition (inspect jaw plates, rolls and screens for wear and blinding).

10) Nominal top size of feed and crusher products.

11) Staff training and procedures for manual assessment.

12) Previous mechanical and operational inspections.

6.2 Mechanical inspections

It is suggested that the inspector start at the primary cutter and follow through the system to the final on-line sample-collection point. The mechanical inspection should be made both with and without material running through the system. Mechanical inspections should be carried out at more frequent intervals than audits. For systems in daily use, it is recommended that mechanical inspections be carried out at least once per month by the management of the sampling system, and not by the direct operators of the system.

The following items should be inspected.

a) The falling-stream and/or cross-belt cutter apertures to determine that they comply with the requirements of ISO 12743 or ISO 20212 and with the design flow chart of the system.

b) The speed in both directions of all cutters. Check that the speed is constant for both time-based and mass-based sampling. For mass-based sampling, it is also possible to use a variable-speed cutter. In this case, check the speed at several flow rates to ensure that the speed is proportional to the flow rate. All weighing devices must be checked regularly to ensure their reliability.

c) The movement of all cutters to verify uniform speed while in the material stream.

d) For all cutters, that the proper number of increments is taken to satisfy the requirements of ISO 12743 or ISO 20212. It should also be determined that the time or mass interval between primary cuts is correct to ensure that the minimum number of increments are collected for the lot being sampled during the inspection based on maximum attainable feed rates.

e) That all cutters are parked out of the stream in the “at rest” position and that no material is entering the cutter opening. There should be no holes in the baffle plates, dust doors, or seals that may cause leaking of material into the primary sample hopper.

f) For falling-stream and/or cross-belt cutters, that the masses of increments conform with ISO 12743 or ISO 20212.

g) Belt feeders (sample conveyors) and vibrating feeders for good condition. This is especially important for sample integrity. The correct tracking of belts, condition of belts, skirt rubbers and belt scrapers can have a significant impact on sample integrity. Check that the belt scrapers and skirts are adjusted properly to avoid spillages. Check the flow rate settings of vibrating belt feeders.

h) The general condition of crushers, including measurement of crusher gaps, and the particle size of crushed products. Variations in product size over time can indicate that maintenance is required to screens, jaw plates, and rolls and gaps in roll crushers. Ensure that the crusher body and chutes are not spilling material from the system.

i) The canisters of rotary sample dividers to ensure that they are free of distortions, perforations and cracks in welds to guarantee correct distribution of material and prevent any material loss.

j) The final sample collector to determine the general condition. Checks should be made to ensure that sample integrity is not being compromised through contamination, sample loss or moisture loss.

k) Records of previous operations and inspections.

6.3 Operational inspections

Operational inspections should be carried out immediately prior to, during and immediately after each sampling operation. This inspection would be due at changes of shift or concentrate/ore type, or for each lot. The emphasis of operational inspections should be on ensuring that the sampling system is operated at correct settings and that reliable operation will be achieved during the sampling period. It is recommended that operational inspections be carried out by the direct operators of the system. The following points should be checked and reported.

a) Operational settings are correct, taking into account the lot size, number of primary increments and sample-collection interval.

b) All equipment and sample chutes are clear of material build-up or blockages. Evidence of chute damage due to damage to external walls or scraping should be recorded.

c) All equipment and sample chutes are clear of foreign material, such as wood, paper, rags, rocks or metal, and there is no contamination from water that may have entered the sampling system.

d) All drives have been checked for correct operation, with attention paid to smooth operation of sample cutter drives. Any unusual noises or vibrations should be reported.

e) All drives, including hydraulic systems, have been started well before sampling is required. Hydraulic systems require a period of time to attain temperature equilibrium.

f) The sampling system has been "conditioned" by passing one or more primary increments through the sampling system before commencing or recommencing sampling. Any sample collected during conditioning should be discarded.

g) Control charts have been maintained in accordance with 6.4. This will provide evidence of restricted flow through the system, should this occur. An example of this inspection summary can be found in Annex C.

6.4 Control charts

6.4.1 General

In addition to the operator's sampling record, it is recommended that control charts also be maintained. Two types of control charts are recommended: for sampling ratio and for extraction ratio.

6.4.2 Sampling ratio

The sampling ratio, R_S, is the actual mass of sample, m_A, in kilograms, divided by the mass of material that it represents, m_{SL}, in tonnes, expressed by the following equation:

$$R_S = \frac{1\,000 m_A}{m_{SL}}$$

The sampling-ratio control chart is a plot of the sampling ratio as a function of increments sampled. Sampling-ratio comparisons should be made only for similar system settings (same cutter apertures, timer settings, sub-lot size and mass flow rate through the system), so a separate control chart is required for each set of system settings used. Samples having a sampling ratio out of control are suspect and should be investigated for validity. When there is a significant variation in the sampling ratio, the reasons for this should also be investigated. An example of an inspection summary and the associated sampling-ratio control chart is shown in Table 1 and Figure 1, respectively.

6.4.3 Extraction ratio

The extraction ratio, R_e, is the actual mass of the sample, m_A, in kilograms, divided by the mass of sample, m_C, in kilograms, calculated from the material flow rate, frequency of cuts, cutter aperture and cutter speed as expressed by the following equation:

$$R_e = \frac{m_A}{m_C}$$

The extraction ratio can be applied to primary increments or at any convenient subsequent sampling stage.

The example shown in Figure 1 is calculated for a single lot from the data in Table 1. However, in practice extraction-ratio control charts are constructed for multiple lots to indicate long-term trends. Thus, each point on an extraction-ratio control chart represents one lot sampled. The data are plotted over many lots, and long-term trends for a particular system can be monitored. Control limits for the extraction ratio are based on the average moving range. The aim in practice should be set at unity (1), not to the average of the data. When the extraction ratio differs significantly from one, the system should be audited and investigated.

The extraction ratio is useful in determining whether there are long-term problems with a particular system. For example, if a cutter speed decreased over several weeks due to a faulty drive, the mass of sample passing through the system would increase and the long-term extraction-ratio data would indicate a problem with the system. When system settings are changed, the extraction ratio is less likely to change than the sampling ratio, so it is more useful in comparing the effectiveness of different sampling systems. An example of an inspection summary and the associated extraction-ratio control chart is shown in Table 1 and Figure 1, respectively.