International Standard ISO 3084

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Iron ores — Experimental methods for evaluation of quality variation

Minerais de fer — Méthodes expérimentales d'évaluation de la variation de qualité

Second edition — 1986-11-15

UDC 553.31.001.4 **Ref. No. ISO 3084-1986 (E)**

Descriptors : metalliferous minerals, iron ores, quality control.

Price based on 11 pages

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 3084 was prepared by Technical Committee ISO/TC 102, *Iron ores.*

This second edition cancels and replaces the first edition (ISO 3084-1975), of which it constitutes a minor revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Iron ores — Experimental methods for evaluation of quality variation

1 Scope and field of application

This International Standard specifies experimental methods for the evaluation of quality variation of iron ores for the purpose of defining the sampling procedure by the stratified method, the systematic method and the two stage method as specified in ISO 3081 or ISO 3082.

NOTE — The experimental methods may be applied approximately to time basis sampling where the variation of the flow of the ores is not so large.

2 References

ISO 3081, *Iron ores — Increment sampling — Manual method.*

ISO 3082, *Iron ores — Increment sampling and sample preparation — Mechanical method.*[1]

ISO 3083, *Iron ores — Preparation of samples — Manual method.*

ISO 3085, *Iron ores — Experimental methods for checking the precision of sampling.*

ISO 3086, *Iron ores — Experimental methods for checking the bias of sampling.*[1]

3 General conditions

3.1 Quality variation

The magnitudes of quality variation or degrees of heterogeneity of iron ores shall be determined by standard deviation as described in 3.1.1 and 3.1.2.

3.1.1 Stratified sampling and systematic sampling

The standard deviation of a quality characteristic between increments taken from within strata, denoted by σ_w, shall be determined.

3.1.2 Two stage sampling as applied to sampling from wagons or containers[2]

The standard deviation of a quality characteristic between increments taken from within wagons selected, denoted by σ_w, and the standard deviation between wagons selected from a consignment, denoted by σ_b, shall be determined.

3.2 Quality characteristics

The quality characteristic chosen for determining the quality variation is generally the total iron content; however, it should be recognized that the moisture content, size distribution and other quality characteristics may have to be taken into account. In this case, the criteria for classification of quality variation (see clause 6) shall be established beforehand.

3.3 Iron ores to be classified

Quality variation shall be determined for each type of iron ore specified between the contracting parties.

3.4 Sampling, sample preparation and testing

Sampling, sample preparation and testing of the sample for this investigation shall be carried out in accordance with the relevant International Standards.

3.5 Execution of investigation

The sampling for this investigation may be conducted in conjunction with routine sampling for the determination of quality of the consignment. In other words, the same sample collected from the consignment may be used for both purposes.

4 Method of investigation for stratified sampling and systematic sampling

The procedures for the evaluation of standard deviation within strata, σ_w, applicable to both stratified sampling and systematic sampling, are described in 4.1 to 4.6.

1) At present at the stage of draft.

2) Hereinafter referred to simply as "wagons".

4.1 Type of investigation

4.1.1 Type 1

When large-size consignments are infrequently delivered, the quality variation may be derived from a single consignment.

Split the consignment into at least 10 parts of almost equal mass.

Then make up a pair of subsamples for each part by combining the increments involved in each part as shown in figure 1a) and example 1.

4.1.2 Type 2

When small-size consignments are frequently delivered, the quality variation may be derived from several consignments of almost equal mass.

Split all the consignments involved into at least 10 parts of almost equal mass.

Then make up a pair of subsamples for each part by combining the increments involved in each part as shown in figure 1b) and example 2.

4.1.3 Type 3

When consignments are frequently delivered and investigation by type 1 or type 2 is uneconomical, the quality variation may be derived from a larger number of consignments of almost equal mass.

Make up a pair of subsamples for each consignment as shown in figure 1c) and example 3.

4.1.4 Type 4

In the case of sampling from a wagon-borne consignment and when the increments are taken from all the wagons of the consignment, the sampling scheme may be regarded as a method of stratified sampling.

Make up a pair of subsamples for each consignment as shown in figure 1d).

4.2 Number of increments and composition of subsamples

4.2.1 Number of increments

The number of increments to be taken from one or several consignments for this investigation may be the same as that selected for routine sampling. However, when the routine sampling is based on the classification category of "small" quality variation (see table 4 of ISO 3081 or ISO 3082) and the number of increments is considered to be insufficient to obtain a reliable standard deviation, then the number of increments shall be increased.

4.2.1.1 In the case of investigation type 1, the number of increments, n_1, shall be determined from table 4 of ISO 3081 or ISO 3082, and the increments taken shall be grouped into at least 10, each made up into a pair of subsamples [see figure 1a)].

4.2.1.2 In the case of investigation type 2, the number of increments, n_1, to be taken from each consignment shall be in accordance with table 4 of ISO 3081 or ISO 3082. The increments corresponding to each consignment shall then be subgrouped on a stratum basis. Each of the increments thus subgrouped should be made up into a pair of subsamples [see figure 1b)].

4.2.1.3 In the case of investigation type 3, the number of increments, n_1, to be taken from each consignment shall be determined from table 4 of ISO 3081 or ISO 3082 [see figure 1c)].

4.2.1.4 In the case of investigation type 4, the number of increments, n_1, being collected from each train of the consignment shall be determined from table 4 of ISO 3081, and the number of increments, n_3, to be taken from each wagon shall be calculated from ISO 3081 [see figure 1d)]. If the number is odd, it shall be increased by one to make it even.

4.2.2 Composition of subsamples

The subsamples shall be made up in accordance with the following procedure:

a) give a serial number to the increments in each part in order of sampling;

b) make up a pair of subsamples from both consecutive odd-number increments (denoted by subsample A_i) and consecutive even-number increments (denoted by subsample B_i) in each part (see figure 2);

c) for each investigation, prepare n sets of paired subsamples.

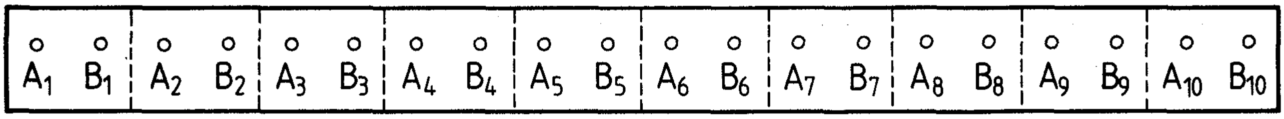
Each subsample shall be made up of two or more increments.

4.3 Preparation of test samples and testing

Test samples shall be prepared separately from all the pairs of subsamples, A_i and B_i.

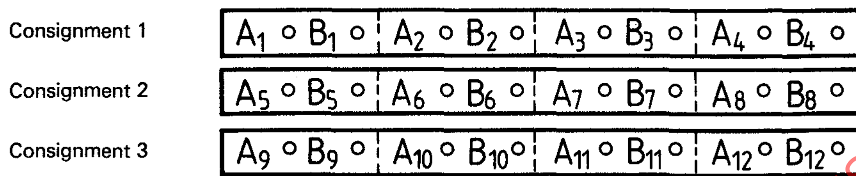
The test sample may be a sample for chemical analysis, moisture determination, size determination, or physical testing, as required.

a) Investigation type 1 — One consignment (Example for 10 parts)

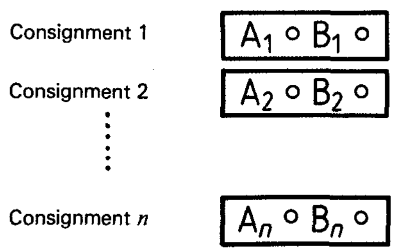


Legend: The rectangular box indicates one consignment; each division of the box made by broken lines indicates one part; a pair of circles indicates a pair of subsamples. [This is applied to a), b) and c).]

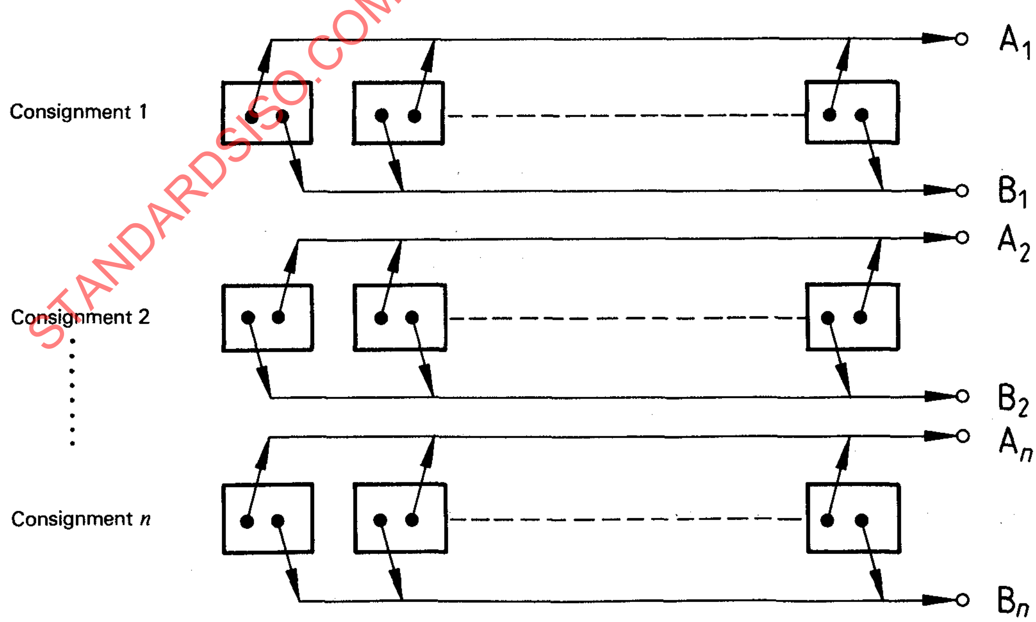
b) Investigation type 2 — Several consignments (Example for three consignments and 12 parts)



c) Investigation type 3 — *n* consignments: one consignment = one part

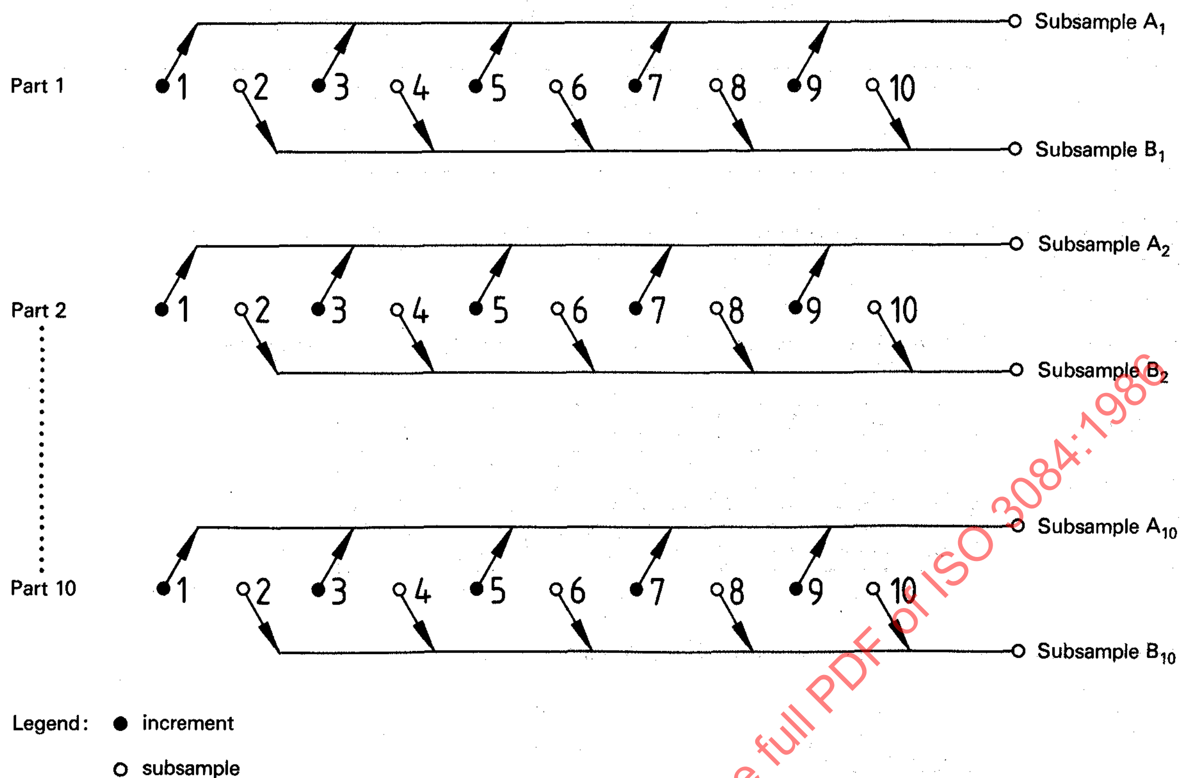


d) Investigation type 4 — Wagon-borne consignments by stratified sampling



Legend: Each box indicates a wagon; points in the box indicate increments; circles indicate subsamples.

Figure 1 — Schematic diagram for one investigation



NOTE — This diagram is based on an example for a single consignment of 5 000 to 15 000 t of ore of "large" quality variation. From table 4 of ISO 3081 or ISO 3082, the required minimum number of increments is 100 and 10 pairs of subsamples A_i and B_i (i = 1, 2, . . ., 10), each comprising five increments, are prepared.

Figure 2 — Example of schematic diagram for composition of pairs of subsamples (type 1)

4.4 Number of investigations

NOTE — As standard deviation within strata, σ_w, cannot be estimated so precisely by a small number of investigations, about 10 separate investigations are recommended.

4.4.1 In the case of investigation types 1 and 2, at least five separate investigations shall be conducted.

4.4.2 In the case of investigation types 3 and 4, at least 10 separate investigations shall be conducted.

4.5 Calculation of standard deviation within strata

4.5.1 Data sheet

The experimental data of chemical analysis, moisture determination, size determination or physical testing as measured on the individual test samples shall be recorded on a suitable form (see examples 1 to 3).

4.5.2 Calculation

The estimated standard deviation within strata shall be calculated from equation (4).

The range, R_i, of paired measurements is given by equation (1).

$$R_i = |A_i - B_i| \qquad \ldots (1)$$

where

A_i is the measurement of quality characterisics (such as % Fe) of the test sample prepared from subsample A_i;

B_i is the measurement of quality characteristic of the test sample prepared from subsample B_i which pairs with subsample A_i;

i is the subscript which designates each part.

The mean, $\bar{R}$, of ranges R_i is given by equation (2).

$$\bar{R} = \frac{1}{n_9} \sum R_i \qquad \ldots (2)$$

where n_9 is the number of R_i, or the number of parts in one investigation.

The mean, $\bar{x}_i$, of paired measurements of each part is given by equation (3).

$$\bar{x}_i = \frac{1}{2} (A_i + B_i) \qquad \ldots (3)$$

The estimated standard deviation within strata, $\hat{\sigma}_w$, in one investigation is given by equation (4).

$$\hat{\sigma}_w = \sqrt{n_{10}} \frac{\bar{R}}{d_2} \qquad \ldots (4)$$

where

n_{10} is the number of increments comprising each subsample A_i or B_i;

d_2 is the factor to estimate standard deviation from the range; for paired data $1/d_2 = 0{,}886\ 5$.

NOTES

1 In the case of investigation type 2, the mean, x_j, of each consignment may be obtained from equation (5) as the routine determined value of quality characteristic of the consignment

$$\bar{x}_j = \frac{1}{n_{11}} \sum x_{ji} \qquad \ldots (5)$$

where

x_{ji} is the mean of paired measurement of each part in consignment j;

n_{11} is the number of parts in the consignment.

2 The estimated standard deviation within strata, $\hat{\sigma}_w$, obtained from equation (4) is a measure of the combined standard deviation of sampling, sample preparation and measurement, and standard deviation within strata is overestimated, but this value may be used for the classification in clause 6 (see 4.6). When it is desired to obtain the estimated standard deviation within strata, and in the case where the estimated standard deviation of sample preparation, denoted by $\hat{\sigma}_D$, and the standard deviation of measurement, denoted by $\hat{\sigma}_M$, are known, the estimated standard deviation within strata should be calculated from equation (6).

$$\hat{\sigma}_w = \sqrt{n_{10} \left[\left(\frac{\bar{R}}{d_2} \right)^2 - \hat{\sigma}_D^2 - \hat{\sigma}_M^2 \right]} \qquad \ldots (6)$$

3 If the number of increments is determined according to 4.2.1 and those increments are taken, the variation in the number of increments comprising each subsample will be small. If the variation is 10 % or less, equations (4) and (6) can be applied approximately by using the mean value of n_{10}.

4.6 Expression of results

4.6.1 In the case of types 1 and 2, the estimated mean value of standard deviation within strata, $\bar{\sigma}_w$, of a particular iron ore evaluated from a series of investigations shall be reported by the square root of the mean of all the values of $\hat{\sigma}_w^2$, i.e.

$$\bar{\sigma}_w = \sqrt{\frac{1}{n_{12}} \sum \hat{\sigma}_w^2} \qquad \ldots (7)$$

where n_{12} is the number of individual values of $\hat{\sigma}_w$.

4.6.2 In the case of types 3 and 4, the value of $\hat{\sigma}_w$ obtained from equation (4) or equation (6) shall be reported as the estimated value of standard deviation within strata of a particular iron ore.

NOTE — In the case of iron content, the value of standard deviation should be rounded off to the first decimal place.

5 Method of investigation for two stage sampling

The method described in this clause covers the procedure for the evaluation of standard deviation within wagons, denoted by σ_w, and standard deviation between wagons, denoted by σ_b, being applicable to the method of sampling from wagons.

NOTE — When the number of wagons making up one train is relatively small, and the sampling scheme requires the collection of increments from all the wagons in the train, then the method of investigation should be that of stratified sampling as specified in type 4.

5.1 Number of sample wagons and number of increments

The number of sample wagons to be selected from a train of wagons and the number of increments to be taken from each of the sample wagons selected shall be determined in accordance with the procedure specified in 5.1.1 to 5.1.3.

5.1.1 The wagon-borne consignment being delivered on either a single train or several may be regarded as the subject of a single investigation; in the case of several trains it is desirable that each train should have almost equal mass.

5.1.2 In the first place, the number of sample wagons, n_{13}, should be determined in accordance with table 1, dependent on the mass of consignment, and then the sample wagons should be selected as determined above.

5.1.3 In the second place, a fixed number of increments, n_{14} (i.e. $n_{14} = 4$), shall be taken from each of the sample wagons.

Table 1 — Number of wagons to be selected per single train

Mass of consignment, m_1 (t)	Number of wagons, n_{13}, to be selected per single train
$8\ 000 < m_1$	8
$4\ 000 < m_1 \leqslant 8\ 000$	6
$2\ 000 < m_1 \leqslant 4\ 000$	4
$m_1 \leqslant 2\ 000$	2

NOTE — This table is designed for convenience only.

5.2 Composition of subsamples

All the increments taken from the sample wagons of a train, i.e. $n_{14}n_{13}$, shall be combined to make up two pairs of subsamples, denoted by A_i, B_i and C_i, D_i, (i = 1, 2, . . ., n) as indicated in figure 3.

5.3 Preparation of test samples and testing

The two pairs of test samples shall be prepared from the two pairs of subsamples A_i, B_i and C_i, D_i in each train.

The test sample may be a sample for chemical analysis, moisture determination, size determination or physical testing, as required.

5.4 Number of investigations

It is recommended that at least 10 separate investigations be carried out.

5.5 Calculation of standard deviation within and between wagons

5.5.1 Data sheet

The experimental data of chemical analysis, moisture determination, size determination or physical testing as measured on the individual test samples shall be recorded on a suitable form (see example 4).

5.5.2 Calculation

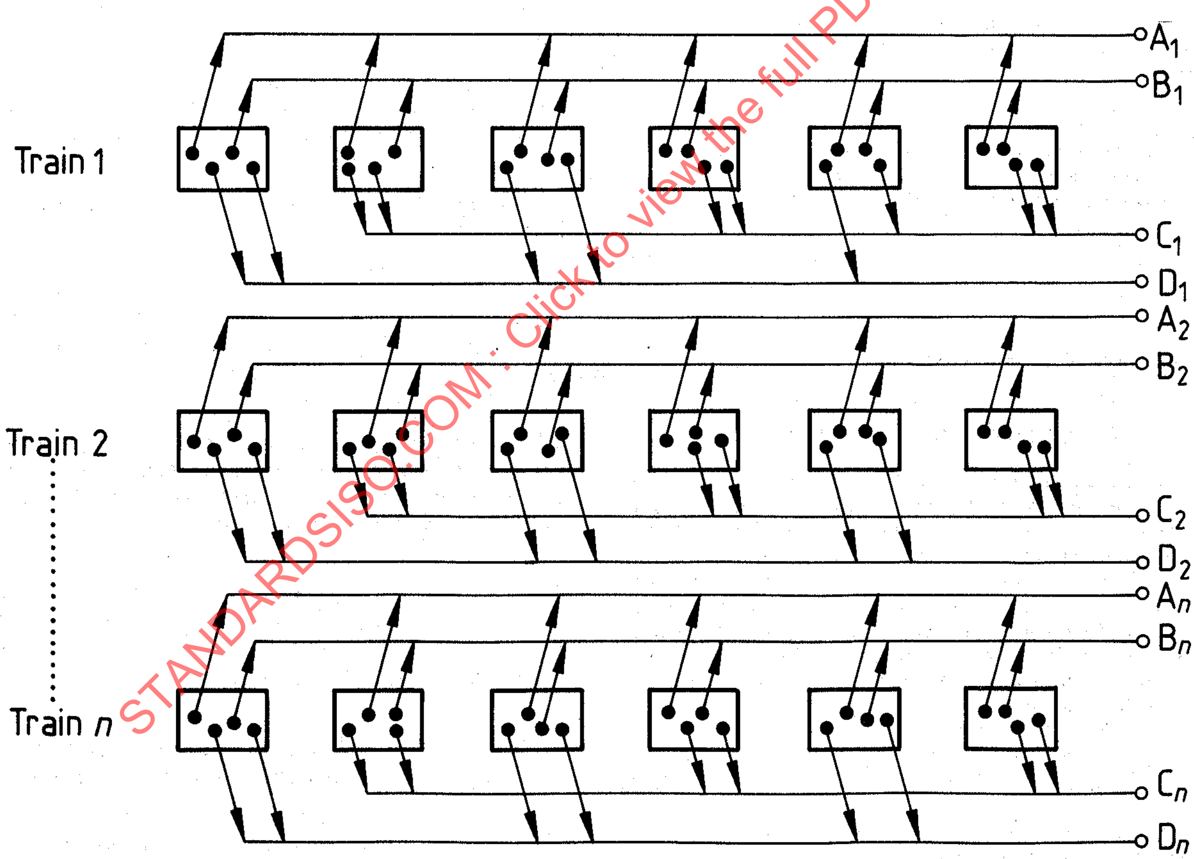
The estimated standard deviation within wagons and between wagons shall be calculated from equations (12) and (13).

The ranges, $R_{A_iB_i}$ and $R_{C_iD_i}$, of respective paired measurements of the test samples are given by equations (8) and (9).

$$R_{A_iB_i} = |A_i - B_i| \quad \ldots (8)$$

$$R_{C_iD_i} = |C_i - D_i| \quad \ldots (9)$$

where A_i, B_i, and C_i, D_i, are the measurements of quality characteristic (such as % Fe) of two pairs of related test samples.



Legend: Each box indicates a sample wagon, and a set of four random points indicates the four increments taken from each sample wagon.

NOTE — This diagram shows those sample wagons which have been selected from each of n trains. It is based on an example for a consignment of 4 000 to 8 000 t of ore.

Table 1 shows the required number of sample wagons (n_2) is equal to six for one train, and two pairs of subsamples, A_i, B_i, and C_i, D_i, each comprising six increments, are prepared.

Figure 3 — Schematic diagram for composition of substrates

The means of the measurements, $\bar{R}_{AB}$ and $\bar{R}_{CD}$, are given by equations (10) and (11).

$$\bar{R}_{AB} = \frac{1}{n} \sum R_{A_iB_i} \qquad \ldots (10)$$

$$\bar{R}_{CD} = \frac{1}{n} \sum R_{C_iD_i} \qquad \ldots (11)$$

where n is the number of trains.

The estimated standard deviations within wagons, $\hat{\sigma}_w$, and between wagons, σ_b, are given by equations (12) and (13).

$$\hat{\sigma}_w = \sqrt{n_{13}}\, \frac{\bar{R}_{AB}}{d_2} \qquad \ldots (12)$$

$$\hat{\sigma}_b = \sqrt{n_{13}\, \frac{\bar{R}^2_{CD} - \bar{R}^2_{AB}}{2d_2^2}} \qquad \ldots (13)$$

where

n_{13} is the number of sample wagons selected from a train of wagons;

d_2 is the factor to estimate standard deviation from the range; for paired data $1/d_2 = 0{,}886\ 5$.

NOTES

1 The mean value, $\bar{x}_i$, of two pairs of measurements of each train or each investigation given by equation (14):

$$\bar{x}_i = \frac{1}{4} (A_i + B_i) + (C_i + D_i) \qquad \ldots (14)$$

may be used as the determined value of quality characteristic for a train of wagons.

2 Equations (12) and (13) are derived from the simultaneous equations (15) and (16) (see figure 3).

$$\left(\frac{\bar{R}_{AB}}{d_2}\right)^2 = \frac{\hat{\sigma}^2_w}{n_{13}\,(n_{14}/4)} \qquad \ldots (15)$$

$$\left(\frac{\bar{R}_{CD}}{d_2}\right)^2 = \frac{\hat{\sigma}^2_b}{(n_{13}/2)} + \frac{\hat{\sigma}^2_w}{(n_{13}/2)\,(n_{14}/2)} \qquad \ldots (16)$$

where $n_{14} = 4$.

3 The estimated standard deviation within strata, $\hat{\sigma}_w$, obtained from equation (12) is a measure of the combined standard deviation of sampling, sample preparation and measurement of the sample, and standard deviation within strata is overestimated. When it is desired to obtain the estimated standard deviation within strata, and in the case where the estimated standard deviation of sample preparation, denoted by $\hat{\sigma}_D$, and the estimated standard deviation of measurement, denoted by $\hat{\sigma}_M$, are known, the estimated standard deviation within strata should be calculated from equation (17).

$$\hat{\sigma}_w = \sqrt{n_{13}\left[\left(\frac{\bar{R}_{AB}}{d_2}\right)^2 - \hat{\sigma}^2_D - \hat{\sigma}^2_M\right]} \qquad \ldots (17)$$

4 When the value obtained from either equation (13) or (17) is negative, it should be taken as zero.

5.6 Expression of results

The estimated mean value of standard deviation, $\bar{\sigma}_w$ and $\bar{\sigma}_b$, of a particular iron ore derived from a series of investigations shall be reported by the square root of the mean of all the values of $\hat{\sigma}^2_w$ or $\hat{\sigma}^2_b$ obtained, i.e.

$$\bar{\sigma}_w = \sqrt{\frac{1}{n_{15}} \sum \hat{\sigma}^2_w} \qquad \ldots (18)$$

$$\bar{\sigma}_b = \sqrt{\frac{1}{n_{15}} \sum \hat{\sigma}^2_b} \qquad \ldots (19)$$

where

$\bar{\sigma}_w$ is the mean of $\hat{\sigma}_w$;

$\bar{\sigma}_b$ is the mean of $\hat{\sigma}_b$;

n_{15} is the number of individual values of $\hat{\sigma}^2_w$ or $\hat{\sigma}^2_b$.

NOTE — In the case of total iron content, the values of standard deviation shall be rounded off to the first decimal place.

6 Classification of quality variation

The quality variation of iron ore shall be classified into one of the three categories specified on the basis of the values of standard deviation derived from a series of investigations.

The criteria for the classification shall be as given in table 2.

Table 2 — Classification of quality variation on the values of standard deviation in the total iron content

Classification of quality variation	Standard deviation in the total iron content (%)
Large	σ_w (or σ_b) $\geqslant 2{,}0$
Medium	$2{,}0 > \sigma_w$ (or σ_b) $\geqslant 1{,}5$
Small	σ_w (or σ_b) $< 1{,}5$

NOTE — It is possible that the quality variation may vary because of changes to factors such as

a) ore bodies in a mine;

b) the method of mining;

c) the method of ore dressing;

d) the method of stockpiling and reclamation;

e) the method of loading/discharging;

f) the mass of the consignment.

Accordingly, the quality variation of any given ore should be checked from time to time to verify the influence of such changes.

Examples for calculation of standard deviation

Example 1: Stratified sampling for one consignment [see figure 1a)]

Particulars of consignment

Name of iron ore: ....

Type of iron ore: (for example lump ore) ....

Classification of quality variation: "Large"

Name of consignment: (for example name of ship) ....

Date of delivery: ....

Mass of consignment: 29 874 t (wet)

Particulars of sampling

Mass of increment: 150 kg

Number of increments: 120

Number of parts: $n_9 = 10$

Number of increments comprising subsample: $n_{10} = 120/(10 \times 2) = 6$

Part No.	−10 mm (undersize) %				Moisture %				Fe %			
	A_i	B_i	$\bar{x}_i$	R_i	A_i	B_i	$\bar{x}_i$	R_i	A_i	B_i	$\bar{x}_i$	R_i
1.	30,2	35,5	32,8	5,3	5,75	6,06	5,90	0,31	60,95	61,61	61,28	0,66
2.	27,8	34,7	31,2	6,9	6,17	5,90	6,04	0,27	62,29	61,42	61,86	0,87
3.	24,7	19,6	22,2	5,1	5,90	6,48	6,19	0,58	61,97	62,90	62,44	0,93
4.	22,4	26,3	24,4	3,9	6,10	6,43	6,26	0,33	61,77	62,45	62,11	0,68
5.	13,3	7,9	10,6	5,4	5,24	4,60	4,92	0,64	64,62	63,48	64,05	1,14
6.	19,7	29,2	24,4	9,5	5,95	6,92	6,44	0,97	63,16	62,13	62,64	1,03
7.	28,1	14,3	21,2	13,8	6,26	5,20	5,73	1,06	62,38	63,60	62,99	1,22
8.	9,4	14,3	11,8	4,9	4,65	5,38	5,02	0,73	63,98	63,09	63,54	0,89
9.	14,0	16,1	15,0	2,1	5,39	5,10	5,24	0,29	63,26	63,80	63,53	0,54
10.	17,3	13,1	15,2	4,2	4,95	5,31	5,13	0,36	62,31	63,24	62,78	0,93
$\bar{\bar{x}} = (1/10)\ \Sigma\bar{x}_i$			20,9				5,69				62,72	
$\bar{R} = (1/10)\ \Sigma R_i$				6,11				0,554				0,889
$\hat{\sigma}_w^2 = 6\ (\bar{R} \times 0{,}886\ 5)^2$				176,031 8				1,447 2				3,726 6
$\hat{\sigma}_w$				13,3				1,20				1,93 → 1,9

Example 2: Stratified sampling for four consignments [see figure 1b)]

Particulars of consignments

Name of iron ore: ....

Type of iron ore: (for example lump ore) ....

Classification of quality variation: "Medium"

Particulars of sampling

Mass of increment: 5 kg

Number of parts in one investigation: $n_9 = (3 \times 4) = 12$

Number of increments comprising subsample: $n_{10} = 60/(3 \times 2) = 10$

Number of parts of each consignment: $n_{11} = 3$

Consignment No.	Name of consignment (for example name of ship)	Date of delivery	Mass of consignment (t) (wet)	Number of increments, n_1
1.	....	....	21 459	60
2.	....	....	20 964	60
3.	....	....	21 400	60
4.	....	....	20 750	60

Part No.	Consignment No.	−10 mm (undersize) % A_i	B_i	$\bar{x}_i$	R_i	Moisture % A_i	B_i	$\bar{x}_i$	R_i	Fe % A_i	B_i	$\bar{x}_i$	R_i
1.	1.	46,8	51,1	49,0	4,3	5,46	6,10	5,78	0,64	62,31	61,44	61,88	0,87
2.		44,7	35,4	40,0	9,3	5,69	5,23	5,46	0,46	63,22	61,86	62,54	1,36
3.		38,2	35,1	36,6	3,1	5,47	5,16	5,32	0,31	62,15	63,19	62,67	1,04
4.	2.	51,2	47,2	49,2	4,0	5,44	5,01	5,22	0,43	62,79	62,22	62,50	0,57
5.		44,0	41,2	42,6	2,8	5,47	5,12	5,30	0,35	62,08	62,92	62,50	0,84
6.		30,9	36,3	33,6	5,4	5,54	4,87	5,20	0,67	63,22	62,57	62,90	0,65
7.	3.	42,4	38,9	40,6	3,5	5,62	5,42	5,52	0,20	64,42	63,28	63,85	1,14
8.		33,7	37,3	35,5	3,6	5,23	5,07	5,15	0,16	63,14	64,01	63,58	0,87
9.		25,3	30,7	28,0	5,4	5,01	5,33	5,17	0,32	64,94	63,98	64,46	0,96
10.	4.	44,5	42,4	43,4	2,1	4,49	4,33	4,41	0,16	64,30	63,56	63,93	0,74
11.		37,9	33,2	35,6	4,7	4,34	4,58	4,46	0,24	64,33	65,65	64,99	1,32
12.		25,9	32,2	29,0	6,3	4,85	4,38	4,62	0,47	64,12	65,25	64,68	1,13
$\bar{\bar{x}} = (1/3)\ \Sigma \bar{x}_{1i}$				41,9				5,52				62,37	
$\bar{\bar{x}} = (1/3)\ \Sigma \bar{x}_{2i}$				41,8				5,24				62,63	
$\bar{\bar{x}} = (1/3)\ \Sigma \bar{x}_{3i}$				34,7				5,28				63,96	
$\bar{\bar{x}} = (1/3)\ \Sigma \bar{x}_{4i}$				36,0				4,50				64,53	
$\bar{R} = (1/12)\ \Sigma R_i$					4,54				0,368				0,958
$\hat{\sigma}_w^2 = 10\ (\bar{R} \times 0{,}886\ 5)^2$					161,982 9				1,064 3				7,212 5
$\hat{\sigma}_w$					12,7				1,03				2,69 → 2,7

NOTE — The symbols $\bar{\bar{x}}_1$, $\bar{\bar{x}}_2$, . . . correspond to consignment No. 1, 2, . . . respectively.

Example 3: Stratified sampling for 13 consignments: one consignment = one part [see figure 1c)]

Particulars of consignment

Name of iron ore: ....

Type of iron ore: (for example lump ore) ....

Classification of quality variation: "Small"

Particulars of sampling

Mass of increment: 25 kg

Consignment No.	Name of consignment (for example name of ship)	Date of delivery	Mass of consignment (t) (wet)	Number of increments, n_1	Number of increments comprising subsample $n_{10} = 20/2 = 10$
1.	....	....	3 023	20	10
2.	....	....	2 998	20	10
3.	....	....	2 895	20	10
4.	....	....	2 824	20	10
5.	....	....	2 834	20	10
6.	....	....	2 825	20	10
7.	....	....	2 182	20	10
8.	....	....	3 040	20	10
9.	....	....	2 925	20	10
10.	....	....	3 028	20	10
11.	....	....	2 218	20	10
12.	....	....	3 056	20	10
13.	....	....	3 100	20	10

Consignment No.	− 10 mm (undersize) %				Moisture %				Fe %			
	A_i	B_i	$\bar{x}_i$	R_i	A_i	B_i	$\bar{x}_i$	R_i	A_i	B_i	$\bar{x}_i$	R_i
1.	30,9	39,2	35,0	8,3	5,99	6,06	6,02	0,07	60,25	60,50	60,38	0,25
2.	31,5	35,2	33,4	3,7	5,37	5,81	5,59	0,44	61,80	61,60	61,70	0,20
3.	38,1	42,1	40,1	4,0	5,44	5,63	5,54	0,19	61,10	61,20	61,15	0,10
4.	37,8	37,2	37,5	0,6	4,70	4,58	4,64	0,12	62,05	62,00	62,02	0,05
5.	42,7	40,3	41,5	2,4	4,83	4,96	4,90	0,13	61,58	61,50	61,54	0,08
6.	26,0	26,7	26,4	0,7	5,05	5,26	5,16	0,21	62,20	61,65	61,92	0,55
7.	36,0	38,3	37,2	2,3	5,61	5,67	5,64	0,06	61,35	61,10	61,22	0,25
8.	31,7	38,2	35,0	6,5	5,11	5,53	5,32	0,42	62,00	62,20	62,10	0,20
9.	41,0	34,7	37,8	6,3	3,75	3,73	3,74	0,02	64,25	64,40	64,32	0,15
10.	15,9	20,1	18,0	4,2	5,46	5,42	5,44	0,04	63,30	63,30	63,30	0,00
11.	16,7	19,5	18,1	2,8	5,00	5,16	5,08	0,16	64,05	64,15	64,10	0,10
12.	25,0	23,4	24,2	1,6	5,64	5,48	5,56	0,16	62,85	63,05	62,95	0,20
13.	30,0	34,8	32,4	4,8	5,75	5,75	5,75	0,00	59,60	59,20	59,40	0,40
$\bar{\bar{x}} = (1/13)\ \Sigma \bar{x}_i$			32,0				5,26				62,01	
$\bar{R} = (1/13)\ \Sigma R_i$				3,71				0,155				0,195
$\hat{\sigma}_w^2 = 10\ (\bar{R} \times 0{,}886\ 5)^2$				108,169				0,188 8				0,298 8
$\hat{\sigma}_w$				10,4				0,43				0,54 → 0,5