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International Standard ISO 3081

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

Iron ores — Increment sampling — Manual method

Minerais de fer — Échantillonnage par prélèvements — Méthode manuelle

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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.

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 3081 was prepared by Technical Committee ISO/TC 102, *Iron ores.*

This second edition cancels and replaces the first edition (ISO 3081-1973), tables 1 and 4 and figures 2, 3 and 4 of which have been technically revised.

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.

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Iron ores — Increment sampling — Manual method

1 Scope

This International Standard specifies manual methods of increment sampling on a consignment of iron ore for the purpose of determining the quality characteristics of the consignment, and includes

a) the underlying theory;

b) the basic principles;

c) the basic requirements for the device and its operation.

NOTE — The theory and basic principles given in this International Standard are similar to those given in ISO 3082 and ISO 3083.

2 Field of application

The methods are applicable to the sampling of all iron ores, whether natural or processed (for example, concentrates and agglomerates such as pellets, sinters or briquettes), to obtain samples for the determination of particle size distribution, moisture content, chemical composition, and physical properties.

The methods are applicable to the taking of samples of iron ores from conveyors, railway wagons or containers (including trucks), ships and stockpiles, during bunker discharge or during the loading or discharging of a consignment in cases where manual sampling can be carried out safely.

3 References

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

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

ISO 3084, *Iron ores — Experimental methods for evaluation of quality variation.*

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

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

4 Definitions

For the purpose of this International Standard, the following definitions apply:

4.1 lot: A definite quantity of an ore, processed or produced under conditions which are presumed uniform.

4.2 consignment: A quantity of an ore delivered at one time. The consignment may consist of one or more lots or parts of lots.

4.3 increment: A quantity of an ore taken by a sampling device at one time from a consignment.

4.4 increment sampling: The process in sampling whereby a sample is taken by combining a number of increments from a consignment and intended to represent the consignment.

4.5 manual sampling: Sampling by human effort with sampling devices, including mechanically assisted devices.

4.6 subsample:

(1) A quantity of an ore consisting of two or more increments taken from a consignment.

(2) An aggregation of two or more increments each of which may have been individually crushed and/or divided as necessary.

4.7 gross sample:

(1) The quantity of an ore consisting of all the increments taken from a consignment.

(2) An aggregation of all the increments or all the subsamples each of which may have been individually crushed and/or divided as necessary.

4.8 test sample: Any sample, for the determination of size distribution, moisture content, chemical composition or other physical properties, which is prepared from each increment, each subsample, or from the gross sample in accordance with the specified method for that type of sample.

1) At present at the stage of draft.

4.9 maximum particle size: The particle size expressed in terms of the size of opening of the sieve on which approximately 5 % (m/m) of iron ore is retained.

NOTE — The maximum particle size of the consignment shall be ascertained either from past experience or by experiment. However, if no information is available, visual estimation is acceptable.

4.10 stratified sampling: For a consignment which can be divided into strata, sampling carried out in such a way that specified numbers of increments in proportion to the mass of each stratum are drawn from each stratum.

In this International Standard, the method can be applied to sampling from ships, and to sampling from wagons or containers.

NOTE — A stratum is part of a consignment partitioned according to specific criteria.

4.11 systematic sampling: Sampling in which increments are taken from a consignment at regular intervals.

When a mass interval is adopted, it is called **systematic sampling on a mass basis**, and when a time interval is adopted, it is called **systematic sampling on a time basis.**

The theory of systematic sampling is based on that of stratified sampling and is applied, in this International Standard, to sampling from conveyors and from bunker discharge.

4.12 two-stage sampling: Sampling by which primary sampling units are selected first from a consignment and then secondary sampling units are taken from those selected primary sampling units.

In this International Standard, the method can be applied to sampling from wagons or containers in which a certain number of wagons or containers are selected first as primary sampling units and then increments are taken from those selected wagons or containers as secondary sampling units.

5 General procedures for manual sampling

Sampling shall be carried out while a consignment is being transferred.

The general sampling procedure shall be as follows:

a) identify the consignment or part of the consignment to be sampled;

b) ascertain the maximum particle size of the consignment;

c) determine the mass of increment according to the maximum particle size;

d) ascertain the classification of quality variation of the consignment (see ISO 3084);

e) determine the minimum number of increments to be taken from the consignment, in the cases of systematic and stratified sampling; in the case of two-stage sampling, allocate the wagons or containers to be selected to the entire consignment and the increments to be taken to the points of the wagons or containers selected;

f) determine the interval of taking increments in the case of systematic sampling and stratified sampling or the interval of selecting the wagons or containers on a mass basis;

g) determine the point of sampling and the method of taking increments;

h) take increments having almost uniform mass during the whole period of handling the consignment.

Increments taken by this International Standard shall be prepared in accordance with ISO 3082 or ISO 3083.

6 Fundamentals of sampling

6.1 Overall precision

This International Standard is designed to attain an overall precision, β_{SDM}, as given in table 1, at a probability level of 95 %, with respect to the mean values of the total iron content, moisture content and size fraction of a consignment.[1] However, the overall precision may be agreed upon between the interested parties.

The overall precision of an intermediate mass of consignment other than those shown in table 1 may be obtained by linear interpolation.

Variations from the other tables in this International Standard may be made, provided it can be demonstrated that the overall precision limits given in table 1 can be met. The precision should be determined in accordance with ISO 3085.

Generally, for chemical elements other than total iron, the values of overall precision will be smaller than those for the total iron content specified in table 1.

The overall precision, β_{SDM}, is a measure of the combined precision of sampling, sample division and measurement, and is twice the overall precision in terms of standard deviation, σ_{SDM}, expressed as an absolute percentage, i.e.

$$\beta_{SDM} = 2\sigma_{SDM} = 2\sqrt{\sigma_S^2 + \sigma_D^2 + \sigma_M^2}$$

where

σ_S is the precision of sampling in terms of standard deviation;

σ_D is the precision of sample division in terms of standard deviation;

σ_M is the precision of measurement in terms of standard deviation.

1) The overall precision of physical properties will be added to table 1 in the future.

Table 1 — Overall precision, β_{SDM}

Values as absolute percentages

Quality characteristics			Approximate overall precision, β_{SDM}			
			Mass of consignment (t)			
			270 000 to 210 000	70 000 to 45 000	15 000 to 5 000	Up to and including 500
Total iron content			± 0,35	± 0,4	± 0,5	± 1,0
Moisture content			± 0,35	± 0,4	± 0,5	± 1,0
Size	−200 mm ore	−10 mm fraction, mean 20 %	± 3,5	± 4,0	± 5,0	± 10,0
	−50 mm ore					
	−31,5 +6,3 mm sized ore	−6,3 mm fraction, mean 10 %	± 1,75	± 2,0	± 2,5	± 5,0
	Sinter feed	+6,3 mm fraction, mean 10 %				
	Pellet feed	−45 µm fraction, mean 70 %	± 0,7	± 0,8	± 1,0	± 2,0
	Pellets	−5 mm fraction, mean 5 %				

Table 2 — Minimum mass of increment

Maximum particle size (mm)		Minimum mass of increment (kg)
Over	Up to and including	
150	250	190
100	150	40
50	100	12
22,4	50	4
10	22,4	0,8
	10	0,3

6.2 Minimum mass of increment

6.2.1 The mass of each increment shall be as specified in table 2 according to the maximum particle size of a consignment.

6.2.2 The increments shall be taken in such a manner as to ensure that they are of almost uniform mass. The "almost uniform mass" means that the variation in mass shall be less than 20 % in terms of the coefficient of variation. The coefficient of variation (CV), expressed as a percentage, is defined as the ratio of standard deviation, s, relative to the mean value, m, of the mass of the increments times 100:

$$\frac{s}{m} \times 100 < 20\ \%$$

6.3 Classification of quality variation

The quality variation is a measure of the heterogeneity of a consignment.

6.3.1 In the case of systematic sampling and stratified sampling, the quality variation, denoted by σ_w, is the standard deviation of a quality characteristic between increments taken from within the strata of the consignment.

In the case of two-stage sampling the quality variation is expressed by σ_b and σ_w; σ_b is the quality variation between wagons or containers selected from the consignment in terms of standard deviation; σ_w is the quality variation in terms of standard deviation between increments taken from within wagons or containers selected.

6.3.2 The values of σ_w and σ_b shall be estimated for each type or each brand of iron ore and for each handling system, under normal operating conditions, in accordance with ISO 3084, and the iron ore shall be classified with respect to the magnitude of quality variation as specified in table 3.

Table 3 — Classification of quality variation, σ_w and σ_b

Values as absolute percentages

Quality characteristics			Classification of quality variation		
			Large	Medium	Small
Total iron content			$\sigma_w \geq 2,0$ or $\sigma_b \geq 2,0$	$2,0 > \sigma_w$ or $\sigma_b \geq 1,5$	$\sigma_w < 1,5$ or $\sigma_b < 1,5$
Moisture content			$\sigma_w \geq 2,0$ or $\sigma_b \geq 2,0$	$2,0 > \sigma_w$ or $\sigma_b \geq 1,5$	$\sigma_w < 1,5$ or $\sigma_b < 1,5$
Size	−200 mm ore	−10 mm fraction, mean 20 %	$\sigma_w \geq 10$ or $\sigma_b \geq 10$	$10 > \sigma_w$ or $\sigma_b \geq 7,5$	$\sigma_w < 7,5$ or $\sigma_b < 7,5$
	−50 mm ore				
	−31,5 +6,3 mm sized ore	−6,3 mm fraction, mean 10 %	$\sigma_w \geq 5$ or $\sigma_b \geq 5$	$5 > \sigma_w$ or $\sigma_b \geq 3,75$	$\sigma_w < 3,75$ or $\sigma_b < 3,75$
	Sinter feed	+6,3 mm fraction, mean 10 %			
	Pellet feed	−45 µm fraction, mean 70 %	$\sigma_w \geq 3$ or $\sigma_b \geq 3$	$3 > \sigma_w$ or $\sigma_b \geq 2,25$	$\sigma_w < 2,25$ or $\sigma_b < 2,25$
	Pellets	−5 mm fraction, mean 5 %			

6.3.3 Any type and/or brand of iron ore whose estimated value of quality variation is unknown shall be considered as having "large" quality variation. In this case, the experiment shall be conducted at the earliest possible opportunity in accordance with ISO 3084, and the classification of quality variation shall be determined.

6.3.4 When separate samples are taken for the determination of size distribution, moisture content, chemical composition and physical properties, the quality variation shall be classified according to the quality characteristic of each sample.

6.3.5 When a sample is to be used for the determination of the value of more than one quality characteristic, the largest classification of quality variation determined shall be applied to the sample.

6.4 Number of increments and precision of sampling

6.4.1 In the case of systematic sampling and stratified sampling, the minimum number of increments to be taken from a consignment in order to attain the desired precision of sampling shall be the number, n_1, specified in table 4 according to the mass of the consignment and the classification of quality variation.

6.4.2 In the case of two-stage sampling, the minimum number of increments shall be obtained from the number of wagons or containers to be selected, n_2, from a consignment in table 5 together with the number of increments to be taken from each wagon or container selected, n_6, in 8.2.

6.4.3 The values of precision of sampling, β_s, in tables 4 and 5 have been determined according to the minimum number of increments stipulated in 6.4.1 and 6.4.2, respectively.

The theoretical backgrounds are described in annex A.

6.5 Method of taking increments

6.5.1 Each increment shall be taken at one time by a single motion of a sampling device from a point selected at random (with equal probability). However, if this is difficult, it may be taken by several motions of the sampling device. The latter shall be proven to have no bias with each type of ore before being applied.

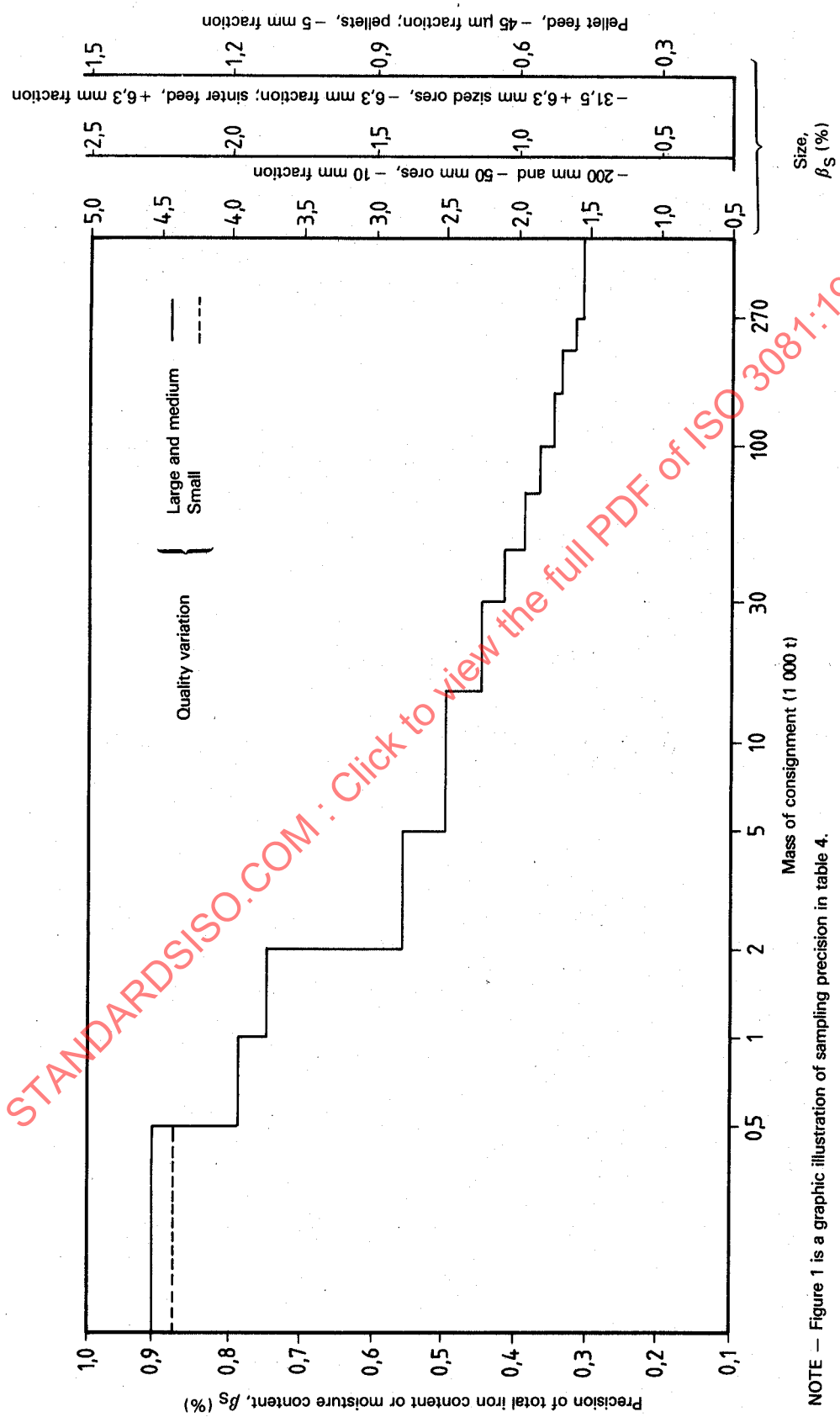
6.5.2 The increments shall be taken in such a manner as to ensure that they are of "almost uniform mass" as described in 6.2.2. In exceptional cases, where increments of almost uniform mass cannot be taken, each increment shall be prepared individually and the quality characteristics of each increment shall also be determined. Alternatively, at an appropriate stage of the sample preparation, the divided increments of almost uniform mass may be combined into a subsample or a gross sample.

6.5.3 When the calculated mass of a sample is less than that required for preparing test samples (for the determination of size distribution, physical properties, etc.) the mass of increment and/or the number of increments to be taken shall be increased.

Table 4 — Minimum number of increments required, n_1, and sampling precision, β_S

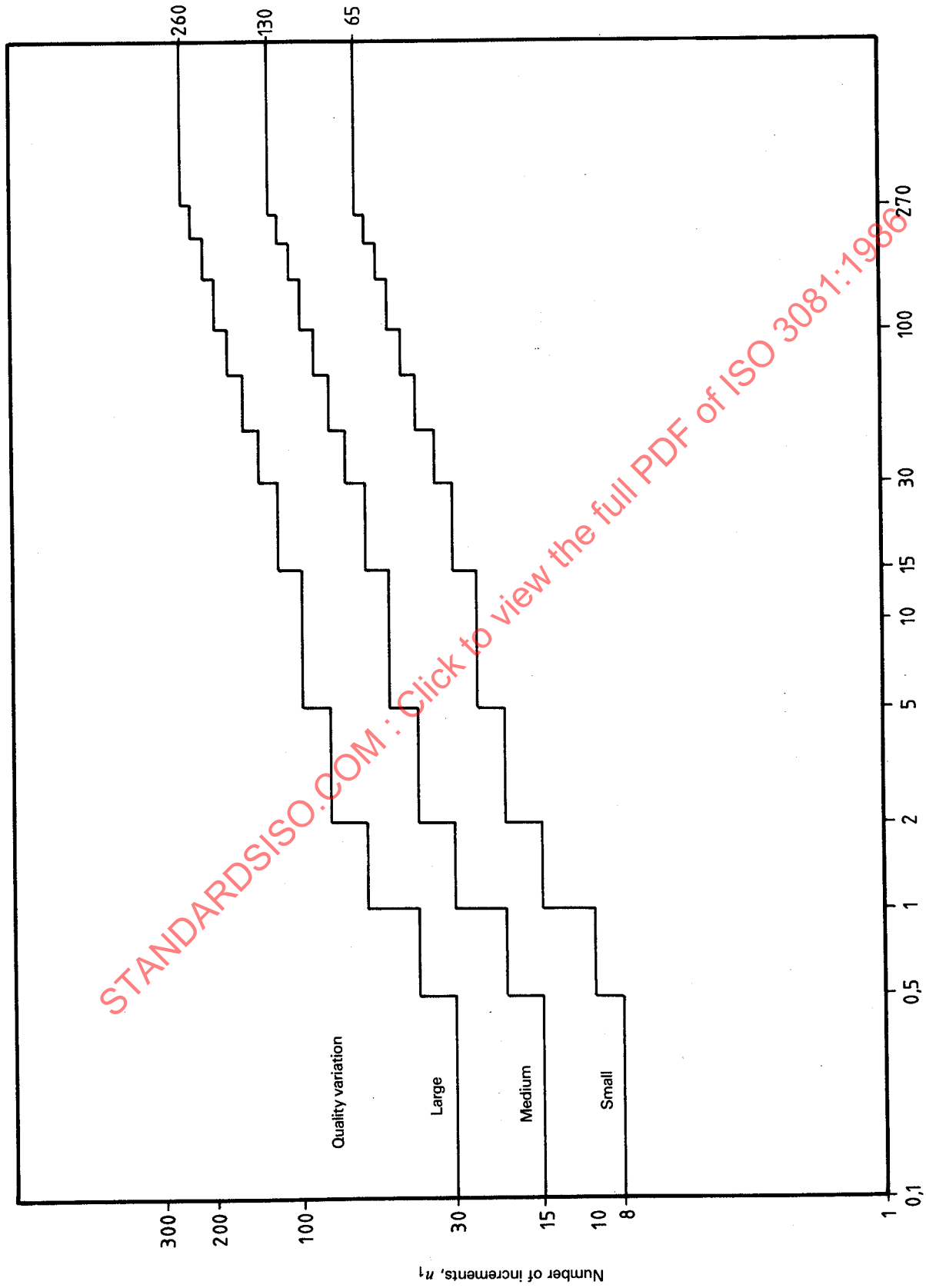
Mass of consignment (t)		Quality variation, σ_w													
		Large					Medium					Small			
			β_S (%)					β_S (%)					β_S (%)		
			Total iron content	Size				Total iron content	Size				Total iron content	Size	
Over	Up to and including	n_1	Moisture content	−200 mm and −50 mm ores, −10 mm fraction	−31,5 +6,3 mm sized ores, −6,3 mm fraction Sinter feed, +6,3 mm fraction	Pellet feed −45 µm fraction Pellets, −5 mm fraction	n_1	Moisture content	−200 mm and −50 mm ores, −10 mm fraction	−31,5 +6,3 mm sized ores, −6,3 mm fraction Sinter feed, +6,3 mm fraction	Pellet feed, −45 µm fraction Pellets, −5 mm fraction	n_1	Moisture content	−200 mm and −50 mm ores, −10 mm fraction	−31,5 +6,3 mm sized ores, −6,3 mm fraction Sinter feed, +6,3 mm fraction	Pellet feed, −45 µm fraction Pellets, −5 mm fraction
270 000		260	0,31	1,55	0,77	0,47	130	0,31	1,55	0,77	0,47	65	0,31	1,55	0,77	0,47
210 000	270 000	240	0,32	1,61	0,80	0,48	120	0,32	1,61	0,80	0,48	60	0,32	1,61	0,80	0,48
150 000	210 000	220	0,34	1,69	0,84	0,51	110	0,34	1,69	0,84	0,51	55	0,34	1,69	0,84	0,51
100 000	150 000	200	0,35	1,77	0,88	0,53	100	0,35	1,77	0,88	0,53	50	0,35	1,77	0,88	0,53
70 000	100 000	180	0,37	1,86	0,92	0,56	90	0,37	1,86	0,92	0,56	45	0,37	1,86	0,92	0,56
45 000	70 000	160	0,39	1,98	0,98	0,59	80	0,39	1,98	0,98	0,59	40	0,39	1,98	0,98	0,59
30 000	45 000	140	0,42	2,11	1,05	0,63	70	0,42	2,11	1,05	0,63	35	0,42	2,11	1,05	0,63
15 000	30 000	120	0,45	2,28	1,13	0,68	60	0,45	2,28	1,13	0,68	30	0,45	2,28	1,13	0,68
5 000	15 000	100	0,50	2,50	1,24	0,75	50	0,50	2,50	1,24	0,75	25	0,50	2,50	1,24	0,75
2 000	5 000	80	0,56	2,80	1,39	0,84	40	0,56	2,80	1,39	0,84	20	0,56	2,80	1,39	0,84
1 000	2 000	60	0,65	3,23	1,60	0,97	30	0,65	3,23	1,60	0,97	15	0,65	3,23	1,60	0,97
500	1 000	40	0,79	3,96	1,96	1,19	20	0,79	3,96	1,96	1,19	10	0,79	3,96	1,96	1,19
	500	30	0,91	4,56	2,27	1,37	15	0,91	4,56	2,27	1,37	8	0,88	4,42	2,21	1,33

NOTE — By agreement between the interested parties and where feasible, the values of n_1 may be increased or decreased. For example if the minimum number of increments is $2n_1$, then β_s will be improved by a factor of $1/\sqrt{2} = 0,71$; and if it is $n_1/2$, then β_s will be worsened by factor of $\sqrt{2} = 1,4$.



NOTE — Figure 1 is a graphic illustration of sampling precision in table 4.

Figure 1 — The precision of sampling for each mass of consignment

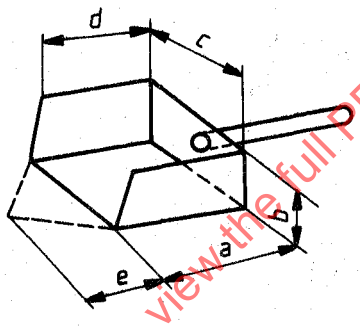


NOTE — Figure 2 is a graphic illustration of the minimum number of increments in table 4.

Figure 2 — Minimum number of increments required

Table 5 — Minimum number of wagons or containers to be selected, n_2

Mass of consignment (t)		Quality variation, σ_b									β_S %	
		Large			Medium			Small				
		Quality variation, σ_w									Total iron or moisture content	Size −10 mm fraction
Over	Up to and including	Large	Medium	Small	Large	Medium	Small	Large	Medium	Small		
20 000		95	85	80	65	55	50	45	35	30	0,50	
16 000	20 000	80	70	65	55	45	40	40	30	25	0,55	2,28
12 000	16 000	65	60	55	45	35	30	30	25	20	0,60	
8 000	12 000	50	45	40	35	30	25	25	20	15	0,65	2,5
4 000	8 000	35	35	30	30	25	20	20	15	15	0,7	
2 000	4 000	25	20	20	20	15	15	15	10	10	0,8	2,8
600	2 000	9	8	8	9	7	6	8	6	5	1,0	3,23



NOTE — The shovel may have a triangular edge which may be convenient for insertion of the shovel into the ore.

Figure 3 — Example of increment shovel

Table 6 — Dimensions of increment shovel

Maximum particle size (mm)	Shovel No.	Dimensions of increment shovel (mm)				
		a	*b*	*c*	*d*	*e*
100	100	300	110	300	220	100
50	50	150	75	150	130	65
22,4	22,4	80	45	80	70	35
10	10	60	35	60	50	25

7 Apparatus

Sampling devices capable of taking the specified mass of increment without introducing bias shall be provided. Among sampling devices, an increment shovel for taking increments from a consignment should be of the type and dimensions given in figure 3 and table 6.

NOTE — Other sampling devices, including mechanically assisted devices, may be used to take increments. These devices should have a minimum opening equivalent to *c* in table 6 and in the case of maximum particle sizes over 100 mm, at least three times this size. The volume of the device in the effective collection area should be sufficient to contain at least twice the minimum mass of increment in table 2.

8 Method of manual sampling

The manual method of increment sampling shall be as specified in 8.1, 8.2, 8.3, or annex B.

8.1 Sampling from conveyors

8.1.1 When the increment is taken from the conveyor after stopping, a section of adequate length in the direction of the stream and of full width and thickness of the ore stream should be taken from the specified position.

The "adequate length" shall be sufficient to ensure that a minimum mass of increment as specified in table 2 can be taken, and shall be more than three times the maximum particle size and at least more than the width of the smallest increment shovel, 60 mm.

When taking the increment from the conveyor, a sampling frame may be used for the sake of convenience.

8.1.2 When the increment is taken from the moving conveyor, the full width and thickness of the iron ore stream should be taken by a mechanically assisted device from the falling stream.

8.1.3 When the effect of segregation in particle size is known to be not significant at the point of sampling and there is no pulsation in the stream, the individual increments may be taken from the points selected at random either on the stopped conveyor or within the falling stream.

8.1.4 The interval of taking increments shall be uniform, on a mass basis, throughout the whole consignment and shall not be changed during the course of sampling.

8.1.4.1 The mass interval, Δm, in tonnes, between taking increments shall be calculated from the formula

$$\Delta m = \frac{m_1}{n_1}$$

where

m_1 is the mass, in tonnes, of the consignment;

n_1 is the number of increments determined in 6.4.1.

8.1.4.2 The mass interval of taking increments shall be determined to be smaller than the calculated mass interval Δm in 8.1.4.1 taking the convenience of operation into account.

8.1.4.3 If the stream of ore is almost uniform, the mass interval may be converted into an equivalent time interval.

8.1.5 The first increment shall be taken after a randomly selected tonnage has been handled within the first mass interval after the start of the handling operation.

8.1.6 The increments shall be taken subsequently at a fixed mass interval until the handling operation of the consignment has been completed.

8.2 Sampling from wagons or containers

8.2.1 Method of taking increments

8.2.1.1 The increments shall be taken at random from the new surface of iron ore exposed during the loading or the unloading of the wagons or containers.

8.2.1.2 When it seems possible that there is some bias in the ore in the wagon or container between strata (between the top and bottom, the front and the rear, or the left and the right), it is advisable to take the increments from each stratum divided in each of the wagons or containers selected.

8.2.1.3 There is a danger of introducing some bias in sampling when the sampling is conducted with a sampling probe or a boring sampler from the top surface of iron ore loaded on wagons or containers, and accordingly, the method shall be applied only after it has been ascertained, by check expreriments, that bias is not significant.

8.2.2 Sampling from all wagons or containers (stratified sampling)

The number of increments, n_3, to be taken from each wagon or container of the consignment shall be calculated from the formula

$$n_3 = \frac{n_1}{n_4}$$

where

n_1 is the number of increments in table 4 according to the mass of the consignment;

n_4 is the number of wagons or containers in the consignment.

The result obtained shall be rounded to the next higher whole number.

8.2.3 Sampling from selected wagons or containers (two-stage sampling)

8.2.3.1 The minimum number of wagons or containers to be selected shall be in accordance with table 5 (see also annex A). Four increments shall be taken from each wagon or container selected, provided that the load is 60 t.

8.2.3.2 When the load of the wagon or container is not 60 t, the minimum number of wagons or containers to be selected, n_5, shall be calculated from the formula

$$n_5 = n_2 \sqrt{\frac{60}{m_2}}$$

where

n_2 is the minimum number of wagons or containers to be selected as given in table 5;

m_2 is the load, in tonnes, of the wagon or container.

The result obtained shall be rounded to the next higher whole number to ensure adequate precision.

Then, the number of increments to be taken from each wagon or container which is not of capacity 60 t, n_6, shall be calculated from the formula

$$n_6 = 4\sqrt{\frac{m_2}{60}}$$

where m_2 is the load, in tonnes, of the wagon or container.

The result obtained shall be rounded to the next lower whole number, because little improvement will be obtained by going to a higher whole number.

8.2.3.3 When the values of σ_w and σ_b are known, a combination of n_2 and n_3 can be selected by the calculation described in annex A.

8.3 Sampling from bunker discharge

The sampling of ore from bunker discharge shall be conducted in accordance with the method specified in 8.1.

9 Packing and marking of sample

The samples for distribution shall be tightly sealed in airtight containers. The following information should be shown on the label and on a card placed in the container, if necessary:

a) type and brand of ore and name of consignment (name of ship, train, etc.);

b) mass of consignment;

c) sample number;

d) place and date of sampling;

e) any other item (if necessary).