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Iron ores — Increment sampling — Manual method

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FOREWORD

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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.

International Standard ISO 3081 (originally Draft International Standard ISO/DIS 2600) was drawn up by Technical Committee ISO/TC 102, *Iron ores*, and circulated to the Member Bodies in March 1972.

It has been approved by the Member Bodies of the following countries :

Australia	Japan	Sweden
Belgium	Netherlands	Thailand
Czechoslovakia	New Zealand	Turkey
Egypt, Arab Rep. of	Poland	United Kingdom
France	Portugal	U.S.A.
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Ireland	South Africa, Rep. of	
Italy	Spain	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Brazil
Canada
Germany

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Iron ores — Increment sampling — Manual method

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the procedure for taking samples of iron ore loaded onto and discharged from conveyors, from railway wagons, from loading bunker discharge, from ships and from stockpiles by the manual[1] increment sampling method, for determining the average value of the quality characteristics of a consignment.

The prescribed methods are applicable to all iron ores, whether natural or processed (pellets, concentrates and agglomerates).

2 REFERENCES

This document should be read in conjunction with the following International Standards :

ISO 3082, *Iron ores — Increment sampling — Mechanical method.* [2]

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

ISO 3084, *Iron ores — Experimental methods for evaluation of quality variation.* [2]

ISO 3085, *Iron ores — Experimental methods for checking the precision of sampling.* [2]

ISO 3086, *Iron ores — Experimental methods for checking the bias of sampling.* [3]

ISO 3087, *Iron ores — Determination of moisture content.* [3]

ISO . . . , *Iron ores — Determination of size distribution by sieving.* [2]

3 DEFINITIONS

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

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

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

3.3 increment : A quantity of an ore obtained by a sampling device at one time from a consignment; also a quantity taken in the increment division method.

3.4 sub-sample : A quantity of an ore consisting of several increments taken from a part of the consignment; also a composite of several increments after having been crushed and divided individually.

3.5 gross sample : The quantity of an ore consisting of all of the increments taken from a consignment; also the composite of all of the increments or all of the sub-samples after having been crushed and divided individually.

3.6 divided sample : A sample obtained by a method of division.

1) The subject of mechanical sampling will be dealt with in ISO 3082, which is in course of preparation. Meanwhile guidance on mechanical sampling is given in the appendix to this International Standard. This appendix is valid only until ISO 3082 is published.

2) In preparation.

3) At present at the stage of draft.

3.7 final sample : Any sample for determination of size distribution, moisture content, chemical composition or other physical characteristics, which is prepared from each increment, each sub-sample, or from the gross sample in accordance with the specified method for that type of sample.

3.8 size sample : The sample taken for the determination of size distribution of the consignment or part of the consignment.

3.9 moisture sample : The sample taken for the determination of moisture content of the consignment or part of the consignment.

3.10 sample for chemical analysis : The sample taken for the determination of chemical composition of the consignment or part of the consignment.

3.11 sample for physical testing : The sample taken for the determination of physical characteristics of the consignment or part of the consignment.

4 GENERAL RULES

4.1 The methods of sampling are different and vary according to the kind of iron ore, the formation and the handling of the consignment, the condition of the consignment and the circumstances under which the sampling is conducted; therefore, it is difficult to fix rigid rules.

4.2 Sampling shall preferably be carried out during shifting of the iron ore immediately before or immediately after weighing.

4.3 Sampling shall be carried out by a periodic systematic increment method with a random start (see 5.6.3).

4.4 The mass of the increment shall be determined in accordance with the maximum particle size of the ore in order to introduce no bias at the time of collecting the sample.

4.5 The number of increments to be taken from a consignment shall be determined according to the heterogeneity of the ore and the desired precision of sampling.

4.6 When a size determination is required, a separate size sample shall be taken.

4.7 Throughout all the procedures of sampling and sample preparation, the samples shall be protected from any alteration.

4.8 All sampling methods shall be confirmed to have no bias, and the proof of no bias should be conducted with reference to the stopped belt sampling (see ISO 3086).

5 METHODS OF SAMPLING IN GENERAL

5.1 General sampling procedure

The general sampling procedures are as follows :

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

2) ascertain the maximum particle size (see Note 1 under Table 1);

3) determine the mass of increment;

4) ascertain the heterogeneity (quality variation) σ_w and σ_b of the consignment (see ISO 3084);

5) determine the number of increments;

6) determine the point of sampling and the method of taking and combining the increments;

7) constitute a gross sample or sub-samples.

5.2 Plan of sampling

The gross sample or sub-samples shall be constituted according to 5.7.

An example is given in Figure 1.

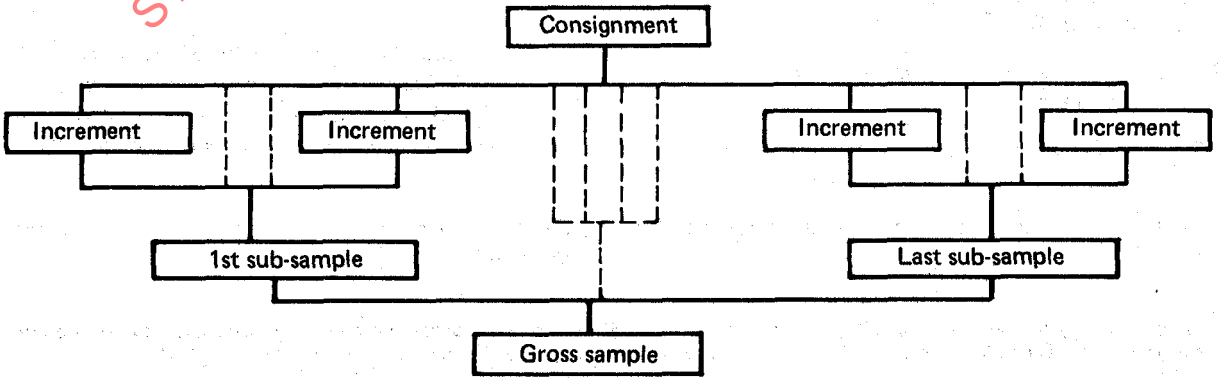


FIGURE 1 — **Example of the plan of sampling**

TABLE 1 — **Mass of increment**

Maximum particle size mm		**Minimum mass of increment** kg	**Shovel No.**	**Dimensions of increment shovel** (see Figure 2) mm				
Over	Up to and including			*a*	*b*	*c*	*d*	*e*
150	250	40						
100	150	20						
50	100	12	100	250	110	250	220	100
20	50	4	50	150	75	150	130	65
10	20	0,8	20	80	45	80	70	35
	10	0,3	10	60	35	60	50	25

NOTES

1 The maximum particle size of the consignment shall be ascertained either visually or from past experience. The term "maximum particle size" designates the size of aperture of the sieve on which approximately 5 % in mass of iron ore is retained.

2 When the maximum particle size is over 100 mm, each increment may be taken by several motions as specified in 5.6.1.

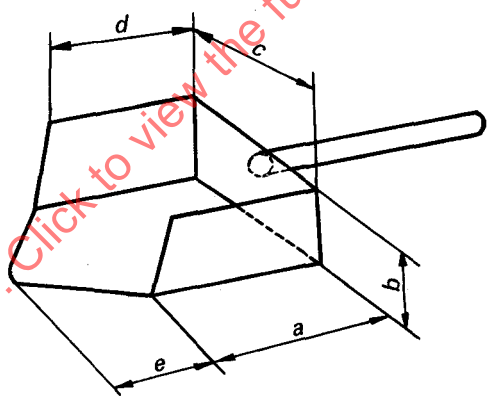


FIGURE 2 — **Increment shovel**

5.3 Mass of increment

The mass of increment specified in Table 1 is the minimum. Therefore, the actual mass of increment shall be chosen at a level higher than those specified in Table 1.

When the mass of increment has been determined, the increments shall be taken in such a manner as to ensure that they have an almost uniform mass.

NOTE — The "almost uniform mass" means that the variation in mass shall be under 20 % in terms of the relative standard deviation (coefficient of variation).

5.4 Precision of sampling and overall precision

This International Standard is designed to obtain a sampling precision (β_s) which is one component of the overall precision (β_{SDM}) given in Table 2. This overall precision shall be based on the fact that sample preparation has been undertaken in accordance with ISO 3083 and that the precision of measurement has been determined by the application of the appropriate International Standard.

The overall precision defines with 95 % probability the average value of the quality characteristics (i.e. iron content, moisture content and size distribution) of a consignment. β_s is a measure of precision of sampling and is twice the standard deviation of sampling, expressed as an absolute percentage. β_{SDM} is also a measure of overall precision for sampling, sample division and measurement and is twice the standard deviation of the overall process of sampling, sample division and measurement, expressed as an absolute percentage.

For chemical elements other than iron, the values of overall precision will be smaller than that for iron content in Table 2.

TABLE 2 – **Overall precision (β_{SDM})**

Quality characteristics			Overall precision (β_{SDM}) (approx.)		
			Mass of consignment (tonnes)		
			70 000 to 45 000	15 000 to 5 000	Up to and including 500
Iron content			± 0,4	± 0,5	± 1,0
Moisture content			± 0,4	± 0,5	± 1,0
Size	(Excluding pellets) – 10 mm fraction		± 4	± 5	± 10
	(In case of pellets) – 5 mm fraction	Average over 5 %	± 1,6	± 2	± 4
		Average less than 5 %	± 0,8	± 1	± 2

NOTE – If a better overall precision (including sampling, sample division and measurement) is required, the values of the quality characteristics of individual increments or sub-samples should be determined by agreement between the parties concerned.

5.5 Number of increments

The number of increments to be taken shall be not less than the number specified in Table 4 and in 6.3.3 according to the mass of consignment and the classification of quality variation (see Note 2).

NOTES

1 σ_w is a measure of heterogeneity of the consignment and is the standard deviation of the quality characteristic of the increment within the strata of the consignment derived experimentally over several consignments.

In the case of sampling from wagons, σ_w in Tables 4 and 6 means the standard deviation within the wagons. σ_b is a measure of heterogeneity between wagons and in Table 6 means the standard deviation between the wagons.

2 The classification of quality variation (σ_w or σ_b) is given in Table 3.

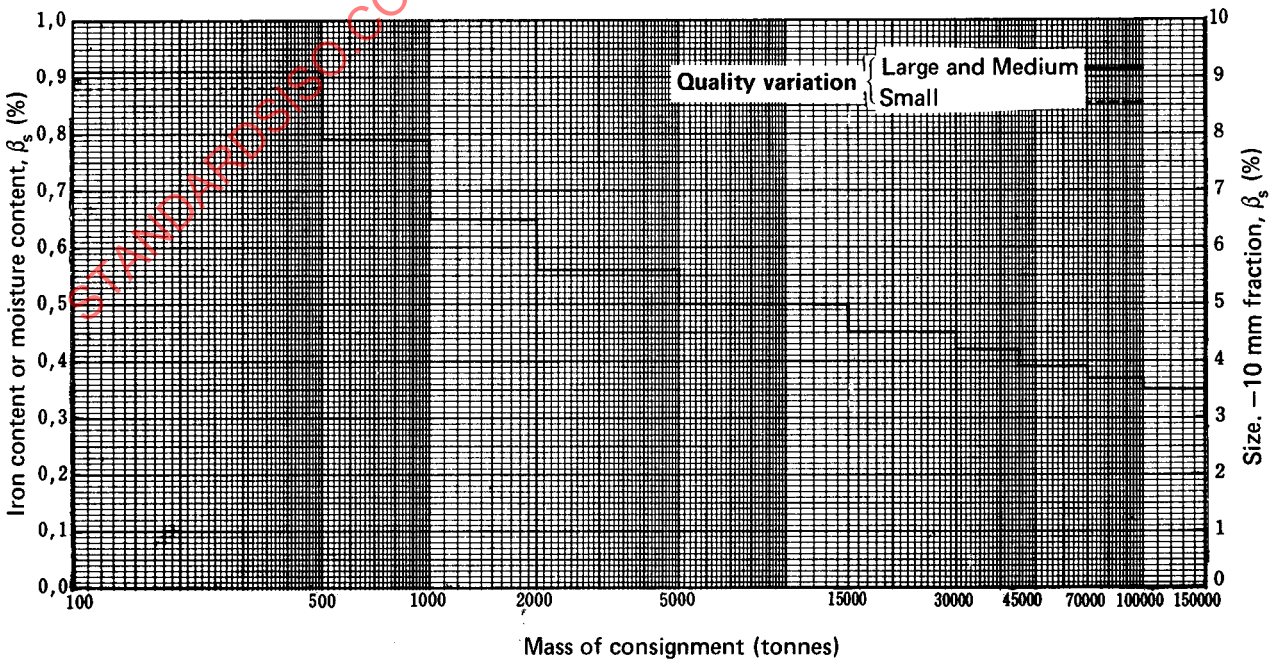
3 All ore, the heterogeneity of which is not known, shall be considered as having "large" quality variation.

TABLE 3 – **Classification of quality variation**

Classification of quality variation	Iron content %	Moisture content %	Size – 10 mm fraction %
Large	σ_w or $\sigma_b \geqslant 2,0$	σ_w or $\sigma_b \geqslant 2,0$	σ_w or $\sigma_b \geqslant 20$
Medium	$2,0 > \sigma_w$ or $\sigma_b \geqslant 1,5$	$2,0 > \sigma_w$ or $\sigma_b \geqslant 1,5$	$20 > \sigma_w$ or $\sigma_b \geqslant 15$
Small	σ_w or $\sigma_b < 1,5$	σ_w or $\sigma_b < 1,5$	σ_w or $\sigma_b < 15$

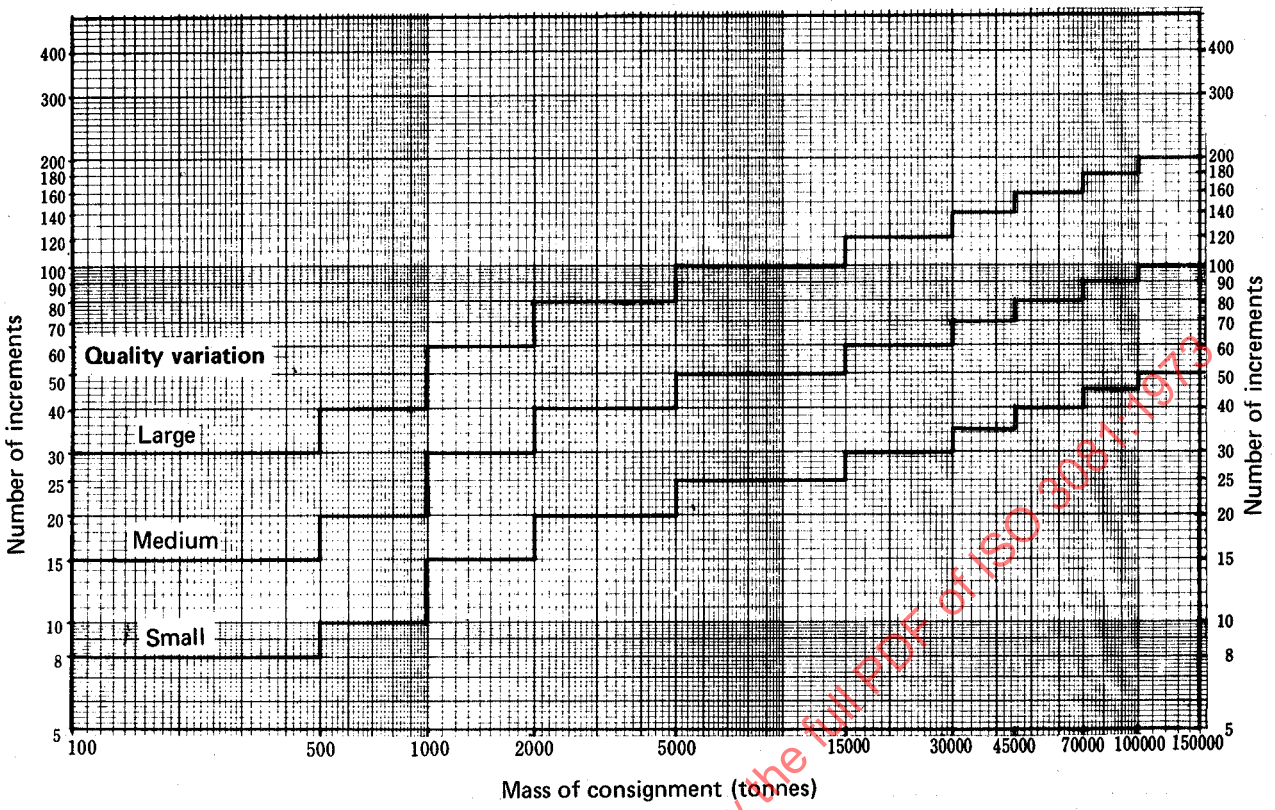
TABLE 4 — **Minimum number of increments required (*n*)**

Mass of consignment tonnes		Quality variation σ_w											
		Large				Medium				Small			
			β_s%				β_s%				β_s%		
Over	Up to and including	*n*	Iron content	Moisture content	Size – 10 mm fraction	*n*	Iron content	Moisture content	Size – 10 mm fraction	*n*	Iron content	Moisture content	Size – 10 mm fraction
100 000	150 000	200	0,35	0,35	3,5	100	0,35	0,35	3,5	50	0,35	0,35	3,5
70 000	100 000	180	0,37	0,37	3,7	90	0,37	0,37	3,7	45	0,37	0,37	3,7
45 000	70 000	160	0,39	0,39	3,9	80	0,39	0,39	3,9	40	0,39	0,39	3,9
30 000	45 000	140	0,42	0,42	4,2	70	0,42	0,42	4,2	35	0,42	0,42	4,2
15 000	30 000	120	0,45	0,45	4,5	60	0,45	0,45	4,5	30	0,45	0,45	4,5
5 000	15 000	100	0,50	0,50	5,0	50	0,50	0,50	5,0	25	0,50	0,50	5,0
2 000	5 000	80	0,56	0,56	5,6	40	0,56	0,56	5,6	20	0,56	0,56	5,6
1 000	2 000	60	0,65	0,65	6,5	30	0,65	0,65	6,5	15	0,65	0,65	6,5
500	1 000	40	0,79	0,79	7,9	20	0,79	0,79	7,9	10	0,79	0,79	7,9
	500	30	0,91	0,91	9,1	15	0,91	0,91	9,1	8	0,88	0,88	8,8



NOTE — This figure is a graphic illustration of β_s in Table 4

FIGURE 3 — **The precision of sampling for each mass of consignment**



NOTE — This figure is a graphic illustration of the minimum number of increments in Table 4

FIGURE 4 — **Minimum number of increments required**

5.6 Method of taking increments

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

5.6.2 Each increment shall be taken during a handling operation from the location selected for sampling.

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

This method is called "periodic systematic sampling".

NOTES

1 The interval between taking increments shall be smaller than that indicated by the number of increments specified in Table 4, in order to ensure that the number of increments to be taken will not be less than the minimum number of increments specified.

2 If the periodic systematic sampling over the whole consignment introduces a systematic error, the consignment shall be stratified into as many strata as the required number of increments and the increment shall be taken at the point determined at random in each stratum.

3 Dependent upon the regularity of the flow of ore, the interval may be expressed on a time basis.

5.6.4 The first increment shall be taken at a time selected at random (with equal probability) within the first interval of taking increments from the start of the handling operation.

5.6.5 When the planned number of increments has been taken and the handling has not been completed, additional increments shall be taken at the same interval until the handling operation is completed.

5.6.6 When the quantity of the gross sample is smaller than that required for testing (size determination, physical testing etc.), either the mass of increment or the number of increments shall be increased beforehand.

5.6.7 Care shall be taken not to produce physical degradation of the sample during the taking of the sample.

5.7 Method of constituting a gross sample or sub-samples

The increments or sub-samples shall be combined together in their entirety into a gross sample.

If the consignment is presumed to be heterogeneous, it shall be divided into as many uniform parts as deemed necessary and sub-samples shall be taken from each part and tested separately.

If better precision is required, each increment should be tested separately.

NOTES

1 When a consignment is very large and a moisture determination is required, it is recommended that a moisture sub-sample be prepared and subjected to moisture determination for each part of the consignment divided into the number of parts indicated in Table 5. This is in order to obtain not only a better precision (including sampling, preparation and moisture determination) but also a result that has no bias.

2 When it takes a long time for loading or unloading of a consignment, the consignment shall be divided for each 8 h handling, and a moisture sub-sample shall be constituted and subjected to moisture determination for each part thus obtained. Such division shall be subject to the condition of weather, for example heavy rain, high temperature, etc. and/or to the conditions or circumstances at the time of loading or unloading, and shall be decided by agreement between the parties concerned.

TABLE 5 – **Minimum number of parts per consignment**

Mass of consignment tonnes		**Minimum number of parts per consignment**
Over	Up to and including	
70 000	150 000	10
30 000	70 000	5
15 000	30 000	3
5 000	15 000	2
	5 000	1

6 VARIOUS SAMPLING METHODS

6.1 Classification of sampling methods

The methods for taking increments from a consignment are classified into the following five methods according to the ore transportation facilities, handling facilities and sampling location :

1) sampling on conveyors;

2) sampling from wagons;

3) sampling from loading bunker discharge;

4) sampling from ships (see B.1 in Annex B);

5) sampling in stockpiles (see B.2 in Annex B).

6.2 Sampling on conveyors

The sampling shall be conducted according to the following procedures in addition to the specified methods of sampling in section 5.

6.2.1 *When and where to take increments*

The increments shall be taken immediately before or immediately after the ore is weighed.

6.2.2 *Method of taking increments*

1) When the increment is taken from the moving conveyor, the full width and thickness of the iron ore stream shall be taken by a sampling device either from the conveyor or from the falling stream.

2) When the increment is taken after stopping the conveyor, a section of adequate length (see Note 1) and full width and thickness of the stream of iron ore shall be taken as the increment from the specified position in the direction of the stream (stopped-belt sampling).

NOTES

1 This length shall be sufficient to ensure that a minimum mass of increment as specified in Table 1 can be taken, and shall be more than three times the maximum particle size.

2 When the maximum particle size is small and no segregation exists at the point of sampling, and there is no pulsation in the flow and the quantity becomes much larger than required if a sampling device cuts the full stream, the individual increments may be taken each time from the points selected at random within the stream.

6.3 Sampling from wagons

6.3.1 *General*

The increment sampling from each wagon shall be conducted as follows :

1) When the number of wagons forming one consignment is not more than the number of increments specified in Table 4, the sampling shall be conducted by taking increments from each wagon according to 6.3.3 (1) (stratified sampling) in addition to the specified methods of sampling in section 5.

2) When the number of wagons forming one consignment is more than the number of increments specified in Table 4 or when a difficulty exists in taking increments from each wagon, the sampling shall be conducted by selecting the wagons to be sampled and then by taking increments at random from each wagon selected according to 6.3.3 (2) (two-stage sampling) in addition to the specified methods of sampling in section 5.

6.3.2 *When and where to take increments*

Each increment shall be taken, as a rule, from the point selected at random in the new surface exposed during the loading or the unloading of the iron ore from the wagons.

NOTE – In cases of the sampling of ores loaded on hopper wagons it is recommended that the sample be taken by mechanical means.

6.3.3 *Number of wagons to be selected and number of increments to be taken*

1) SAMPLING FROM ALL WAGONS (STRATIFIED SAMPLING)

The number of increments which are to be taken from each wagon of the consignment shall be calculated from the following formula :

$$n_w = \frac{n}{M}$$

where

n_w is the number of increments to be taken from each wagon;

n is the number of increments in Table 4 according to the mass of the consignment;

M is the number of wagons in the consignment.

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

2) SAMPLING FROM SELECTED WAGONS (TWO-STAGE SAMPLING)

a) Minimum number of wagons to be selected

The minimum number of wagons to be selected shall be in accordance with Table 6 (see also Annex A).

b) Number of increments to be taken from each selected wagon

Four increments shall be taken from each wagon selected. When the capacity of the wagon is not 60 tonnes, the number of increments to be taken from each wagon selected shall be obtained from the following formula :

$$n_w' = 4\sqrt{\frac{C}{60}}$$

where

n_w' is the number of increments to be taken from wagons other than 60 tonne wagons;

C is the capacity of the wagon, in tonnes.

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

NOTES

1 All ore, the heterogeneity of which is not known, shall be considered as having large quality variation.

2 When the capacity of the wagon is not 60 tonnes, the minimum number of wagons to be selected shall be obtained from the following formula :

$$m' = m\sqrt{\frac{60}{C}}$$

where

m' is the minimum number of wagons to be selected;

m is the minimum number of wagons to be selected as given in Table 6;

C is the capacity of the wagon, in tonnes.

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

6.3.4 *Method of selecting wagons*

The first wagon to be sampled shall be selected at random; thereafter, wagons shall be selected at regular intervals according to the number of wagons required.

6.3.5 *Method of taking increments*

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.

2) When it seems possible that there is a bias in the iron ore on the wagon between the top and bottom, between the front and rear, or between the left and right, it is advisable to conduct stratified sampling or to take the increments from different places in each of the wagons sampled.

3) There is a danger of introducing a bias in sampling when the sampling is conducted with a sampling probe or boring sampler from the top surface of iron ore loaded on wagons, and accordingly the method shall be applied only after having ascertained, by check experiments, that there is no bias present.

6.4 Sampling from loading bunker discharge

The sampling from loading bunker discharge shall be conducted at the falling stream of ore in accordance with the method specified in 6.2.