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General rules for sampling of
ferroalloys

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS G 1501:1985** is replaced with **JIS G 1501:1998**.

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General rules for sampling of ferroalloys

Introduction This revision is executed for the purpose of being coordinated to the corresponding International Standard:

Though this Standard is prepared based on ISO 3713, *Ferroalloys—Sampling and preparation of samples—General rules*, issued as the first edition in 1987 without changing technical contents on the corresponding parts, the items and contents which are not specified in the corresponding International Standard are added as the Japanese Industrial Standard.

Positions with the dotted underline in this Standard are items which do not exist in the corresponding International Standard.

1 Scope This Japanese Industrial Standard specifies general rules common to the sampling methods for determination of the mean values of characteristics (hereafter referred to as “mean grade”) of one consignment of ferroalloys (hereafter referred to as “products”) specified in JIS G 2301, JIS G 2302, JIS G 2303, JIS G 2304, JIS G 2306, JIS G 2307, JIS G 2308, JIS G 2309, JIS G 2310, JIS G 2311, JIS G 2312, JIS G 2313, JIS G 2314, JIS G 2315, JIS G 2316, JIS G 2318 and JIS G 2319.

Remarks: This Standard is, as a rule, based upon JIS M 8100.

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards indicated below shall be applied.

- | | |
|------------|--|
| JIS G 1601 | <i>Methods of sampling for chemical analysis of ferroalloys (Part 1: Ferromanganese, ferrosilicon, ferrochromium, ferrosilicomanganese and ferrosilicochromium)</i> |
| JIS G 1602 | <i>Methods of sampling for chemical analysis of ferroalloys (Part 2: Ferrotungsten, ferromolybdenum, ferrovanadium, ferrotitanium and ferro-niobium)</i> |
| JIS G 1603 | <i>Methods of sampling for chemical analysis of ferroalloys (Part 3: Ferrophosphorus, manganese metal, silicon metal, chromium metal, calcium silicon and ferroboration)</i> |
| JIS G 1604 | <i>Methods of sampling for chemical analysis of ferroalloys (Part 4: Ferro-nickel)</i> |
| JIS G 1641 | <i>Methods of sampling for size analysis of ferroalloys and size determination</i> |
| JIS G 2301 | <i>Ferromanganese</i> |
| JIS G 2302 | <i>Ferrosilicon</i> |
| JIS G 2303 | <i>Ferrochromium</i> |
| JIS G 2304 | <i>Silicon-Manganese</i> |
| JIS G 2306 | <i>Ferrotungsten</i> |
| JIS G 2307 | <i>Ferromolybdenum</i> |

JIS G 2308	<i>Ferrovanadium</i>
JIS G 2309	<i>Ferrotitanium</i>
JIS G 2310	<i>Ferrophosphorus</i>
JIS G 2311	<i>Manganese metal</i>
JIS G 2312	<i>Silicon metal</i>
JIS G 2313	<i>Chromium metal</i>
JIS G 2314	<i>Calcium silicon</i>
JIS G 2315	<i>Silicon-Chromium</i>
JIS G 2316	<i>Ferronickel</i>
JIS G 2318	<i>Ferroboron</i>
JIS G 2319	<i>Ferroniobium</i>
JIS M 8100	<i>Particulate materials—General rules for methods of sampling</i>
JIS Z 8401	<i>Rules for rounding off of numerical values</i>

3 Definitions For the purpose of this Standard, the following definitions apply.

- a) **consignment** A quantity of a ferroalloy delivered at one time. A consignment may consist of one or more lots or parts of a lot.
- b) **lot** A quantity of a ferroalloy produced and processed under conditions which are presumed uniform.
- c) **increment** A quantity of a ferroalloy obtained by a sampling device at one time from a consignment supplied in bulk or in a packed form; also a quantity taken by the increment division method.
- d) **sampling** It is the whole process where a fixed number of increments are taken from a consignment and the test sample is produced by preparation of them.
- e) **systematic sampling** A practical method of random sampling in which increments are taken at specified regular intervals in terms of mass, time or space; the first increment is taken at a randomly selected first interval.

Remarks: The first increment is taken at random from a part of a consignment corresponding to the first interval. This is called “random start”. It is called “mass reference systematic sampling” when the interval is based upon mass, and otherwise called “time reference systematic sampling” when based upon time. It applies to the case where consignments are transported by a belt conveyor or the like.

- f) **stratified sampling** It is the sampling where a consignment is divided into layers (1) and a fixed number of increments is taken from each layer.

Note (1) The layer herein means the part of consignment divided by a fixed reference.

- g) **two-stage sampling** A practical method of random sampling by two stages. Selection

of primary units of sampling (for example, packed units or parts of a consignment) is carried out at the first stage, and then, sampling of secondary units is carried out.

Remarks: The two-stage sampling applies to the sampling from truck, freight car (hereafter referred to as the "truck") straw bag, drum can, container having the same degree capacity (hereafter referred to as the "container") or ingot, etc. For example, a certain fixed number of trucks is systematically or at random selected as the primary sample unit and then, a certain fixed number of increments is taken from the selected trucks as the secondary sample unit.

- h) **manual sampling** It is the sampling where an increment is manually taken by using increment sampling appliances containing ones with mechanical supplementary apparatus.
- i) **mechanical sampling** It is the sampling where an increment is taken by the increment sampling appliance mechanically operated.
- j) **sub-sample** It is the sample prepared by collecting several increments or otherwise, the sample prepared by a method wherein several increments are individually prepared as required and thereafter collected.
- k) **gross sample** It is the sample prepared by collecting all increments or all sub-samples taken from a consignment, or otherwise the sample prepared by a method wherein each increment or each sub-sample is individually prepared as required, and thereafter all of them are collected.
- l) **sample preparation** It is the process where a test sample is prepared from the sampled increments. This process contains the grinding, mixing, reduction, etc. of sample and may be carried out by several stages.
- m) **reduction sample** It is the sample obtained at respective stages of sample reduction, for the purpose of preparation of test sample.
- n) **sample for composition** It is the generic term of sample for the purpose of preparation of test sample for composition.
- o) **sample for particle size** It is the generic term for the purpose of preparation of test sample for particle size.
- p) **test sample** It is the sample with which a fixed preparation can be completed as to each increment, each sub-sample or gross sample and the chemical composition analysis or particle size test can be carried out. It is called the composition test sample or particle size test sample.
- q) **particle size** It is the size of particle expressed by the hole size of the minimum square aperture sieve through which particles pass, or otherwise by the aperture size of the maximum square aperture sieve on which particles remain.
- r) **maximum particle size** It is the particle size expressed by the aperture size of square aperture sieve on which about 5 % of the sample remains.
- s) **particle size which allows the whole quantity of samples to pass through** It is the particle size expressed by the aperture size of the minimum square aperture sieve which all quantity of sample passes through.

- t) **reduction** It is the treatment where in the process of preparation of a test sample from an increment, sub-sample or gross sample, the mass thereof is reduced in accordance with the reduction standard.
- u) **reduction reference** It is the minimum mass of reduced sample specified according to the particle size which allows the whole quantity of sample to pass through.

Remarks: When the mass of reduction sample has been made smaller than the minimum mass thereof, the sample shall be further crushed and reduced.

- v) **proportional reduction** It is the reduction system where the mass of reduction sample is proportional to the mass of sample before reduction in the case of reduction of not less than two increments or sub-samples.
- w) **quantitative reduction** It is the reduction system where the sample having almost fixed mass ⁽²⁾ is obtained regardless of the mass of sample before reduction in the case of reduction of not less than two increments or sub-samples.

Note ⁽²⁾ The dispersion of mass shall be under 20 % in coefficient of variation (CV).

- x) **error** It is the difference between the measured value and the true value.
- y) **precision** It is the span of error distribution (the degree of dispersion). For example, it is expressed by standard deviation.
- z) **bias** It is the difference between the mean value of error distribution and the true value.
- aa) **characteristics** They are quality items especially taken among quality items, for example the chemical composition and/or particle size of product.
- ab) **grade variation** It is the dispersion of characteristics within the product of divided fixed mass or the dispersion of the characteristics between mutual products having divided fixed mass. It is, as a rule, expressed by standard deviation.

4 Symbols Principal symbols used in this Standard shall be as follows:

- σ_s : Sampling precision expressed by standard deviation
- σ_p : Sample preparation precision expressed by standard deviation
- σ_m : Measurement (analysis) precision expressed by standard deviation
- σ_{SM} : Precision where the precision of sampling and measurement (analysis) is in all expressed by standard deviation
- σ_{SPM} : Precision where the precision of sampling, preparation and measurement (analysis) is in all expressed by standard deviation
- σ_w : Dispersion among increments in a layer expressed by standard deviation in systematic and stratified sampling

Further, dispersion among trucks or increments in a container expressed by standard deviation in two-stage sampling

- σ_b : Dispersion among trucks or containers expressed by standard deviation in two-stage sampling

β_s : Sampling precision ($\beta_s = 2\sigma_s$)

β_{SM} : Overall precision as to mean value of particle size of one consignment ($\beta_{SM} = 2\sigma_{SM}$)

β_{SPM} : Overall precision as to mean value of chemical composition of one consignment
($\beta_{SPM} = 2\sigma_{SPM}$)

CV : Coefficient of variation (%)

I_m : Increment sampling interval by mass reference (t)

I_T : Increment sampling interval by time reference (min)

m_c : Mass of consignment (t)

n_1 : Minimum necessary number of increments taken from a consignment

n_2 : Number of increments taken from each truck or container selected

N_1 : Number of trucks or containers composing a consignment

N_2 : Minimum necessary number of trucks or containers selected from a consignment

5 Basic matters

5.1 Grade variation The grade variation is the scale of the heterogeneity of a consignment and, as a rule, expressed by standard deviation. The grade variation shall be examined in accordance with Annex 3 and Annex 4 of **JIS M 8100**.

5.2 Precision The precision shall be as follows:

- a) For the precision, the sampling standards of products, **JIS G 1601**, **JIS G 1602**, **JIS G 1603**, **JIS G 1604** and **JIS G 1641** (hereafter referred to as the "each standard") shall be so established that the mean grade of one consignment as to characteristics specified in each of these standards can be estimated by the overall precision of about 95 % in confidence coefficient. The method for obtaining the precision shall be in accordance with Annex 5 of **JIS M 8100**.
- b) The overall precision (β_{SPM}) contains the precision of sampling, preparation and measurement (analysis) of sample, which is 2 times the value of precision (σ_{SPM}) expressed by standard deviation, and is expressed by absolute percentage. That is,

$$\beta_{SPM} = 2\sigma_{SPM} = 2\sqrt{\sigma_s^2 + \sigma_p^2 + \sigma_m^2}$$

Remarks: In the case where the test sample is prepared for each increment or each sub-sample, or otherwise in the case where the number of measurements (analyses) is increased, the precision further becomes better (refer to **8.1**).

5.3 Increment The increment shall be as follows:

- a) The increment is the basic unit of sampling.
- b) The minimum mass of increment shall be specified in each standard considering so that the product of the maximum particle size in a consignment is at random contained in an increment.
- c) The minimum necessary number of increments to be taken from a consignment shall be

specified in each standard considering the overall precision and grade variation as to characteristics. When necessary, the number of increments shall be respectively specified in each mass, transportation means, precision, characteristics, etc. of consignment. The calculation for obtaining the sampling number of increments shall conform to 10.

- d) The sampling of increment shall be carried out during transportation and the product having almost fixed mass shall be taken at one motion by a manual sampling appliance or a mechanical sampling apparatus.

Further, in the case where the consignment is difficult to be crushed and principally composed of lumpy products (medium and low carbon ferrochromium or the like), a lumpy product is selected as the primary sample unit and an increment shall be taken by denudation, boring and scratching off thereof. Details of this method shall conform to JIS G 1601.

Remarks 1 In the case where it is difficult to take an increment at one manual motion, the product of specified mass may be taken by several motions from one position selected at random, and made to be the increment.

2 When an increment cannot be obtained by almost fixed mass, after the reduction of respective increments to almost fixed mass at a suitable stage of preparation, they are collected into a sub-sample or a gross sample.

3 In the case where the taken increment as it is made the particle size test sample, the increment may not have almost fixed mass.

- e) When there is a fear that the mass of sample may become not more than the required mass for the test (particle size test or the like), the number of increments to be taken shall be increased, or otherwise the minimum mass of increment shall be enlarged.

5.4 General procedures of sampling and preparation of sample General procedures of the sampling and preparation of sample shall be as follows :

- a) Consignments to be sampled shall be clarified.
- b) The method and system of sampling shall be clarified.
- c) The maximum particle size of consignment shall be confirmed.
- d) The minimum mass of increment shall be determined according to the maximum particle size.
- e) In the cases of systematic and stratified sampling, the minimum necessary number of increments to be sampled from a consignment shall be determined.

Further, in the case of two-stage sampling, the number of trucks or containers to be selected from a consignment and the number of increments to be sampled from the selected trucks or containers shall be determined.

- f) In the cases of systematic and stratified sampling, the sampling interval of increment shall be determined. In the case of two-stage sampling, the selecting interval of trucks or containers shall be determined.
- g) The sampling place and position of increment shall be determined.
- h) Over whole the period of handling of a consignment, increments having almost fixed

mass shall be sampled.

- i) The test sample which is prepared from either of each increment or of each sub-sample or of gross sample, shall be determined according to conditions for the purpose of measuring characteristic values.
- j) The process of sample preparation containing crushing, mixing, redaction, etc. shall be established by determine the method for reduction of samples at respective stages.
- k) The test sample shall be prepared according to the above-mentioned procedure.

An example of the sampling and preparation of sample is given in Fig. 1.

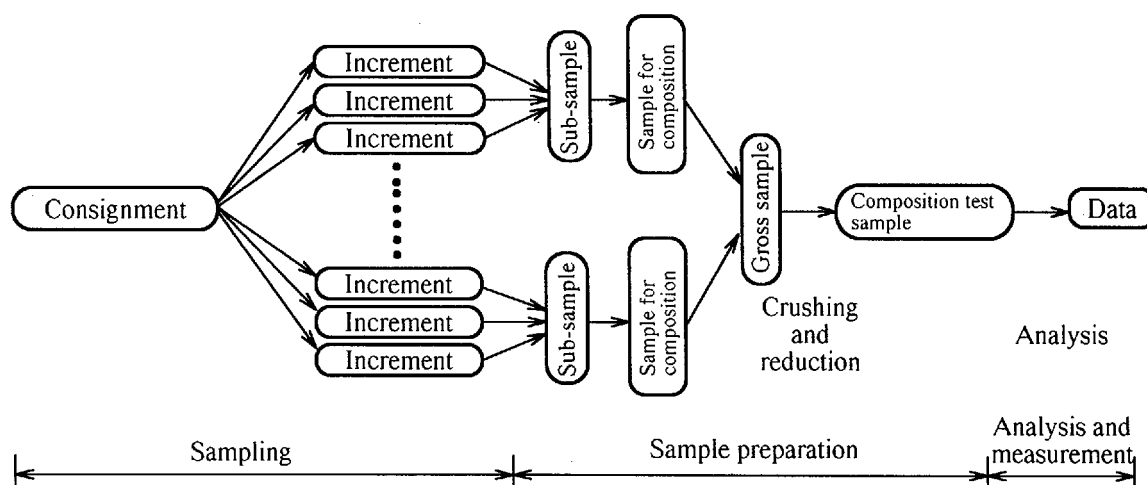


Fig. 1 Outline of sampling and preparation of sample (example)

5.5 Handling of sample Throughout the period for the sampling and preparation of sample, cares shall be taken so that the sample is not damaged and deteriorated and foreign matter not mixed in by taking such means as sufficiently cleaning the appliance and apparatus to be used or the like.

5.6 Determination of mean grade of consignment It shall be determined in accordance with the method specified in 9.

5.7 Rounding-off of numerical values It shall be carried out in accordance with JIS Z 8401.

5.8 Others In the case where a portion of specifications in this Standard is considered difficult to apply, the method subjected to the agreements between the parties concerned with delivery may be used instead of these specifications.

6 Appliances and apparatus of sampling

6.1 General required matters The general required matters shall be as follows:

- a) A complete set of the appliance and apparatus capable of sampling increments of specified mass and of the apparatus capable of sample preparation meeting the sample reduction reference, shall be prepared.