BS EN 15442:2011

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Solid recovered fuels — Methods for sampling

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National foreword

This British Standard is the UK implementation of EN 15442:2011. It supersedes DD CEN/TS 15442:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PTI/17, Solid biofuels.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Solid recovered fuels - Methods for sampling

Combustibles solides de récupération - Méthodes d'échantillonnage

Feste Sekundärbrennstoffe - Verfahren zur Probenahme

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Contents

Page

Foreword 4
Introduction 5
1 Scope 7
2 Normative references 7
3 Terms and definitions 7
4 Symbols and abbreviated terms 10
5 Principle 11
6 Development of a sampling plan 11
6.1 Principle 11
6.2 Definition of overall objectives 13
6.3 Definition of a lot and determining lot size 13
6.4 Determination of the sampling procedure 14
6.5 Determination of the number of increments 14
6.6 Determination of minimum sample size 15
6.7 Determination of the minimum increment size 15
6.8 Determination of the effective increment and sample sizes 15
6.9 Selection of distribution of increments over a lot 16
7 Implementation of the sampling plan 18
7.1 Steps before actual sampling 18
7.2 Steps during sampling 18
7.3 Steps after sampling 19
8 Handling and storage of samples 19
9 Precision 19
Annex A (normative) Procedure for the development of a sampling plan 20
A.1 Introduction 20
A.2 Principle 20
A.3 Procedure 20
Annex B (informative) Guideline for a sampling plan 23
B.1 Introduction 23
B.2 Form for the sampling plan 23
Annex C (normative) Sampling equipment and implements 28
C.1 Introduction 28
C.2 Principle 28
C.3 Selection of an apparatus 28
C.4 Examples for sampling from a moving conveyor or drop flow 28
C.5 Sampling frame 30
C.6 Sampling scoop 31
C.7 Mechanical probe 32
Annex D (normative) Determination of minimum sample size 34
D.1 Introduction 34
D.2 Principle 34
D.3 Determination of factors necessary for the minimum sample size 34
D.4 Calculation of the minimum sample size 36
D.5 Quick determination of minimum sample size 37

Annex E (normative) **Determination of minimum increment size for sampling from material flows** 39
E.1 Introduction 39
E.2 Principle 39
E.3 Determination of minimum increment size for mechanical sampling from a drop flow 39
E.4 Determination of minimum increment size for manual sampling from a drop flow 40
E.5 Determination of minimum increment size for sampling from a conveyor 41

Annex F (normative) **Determination of minimum increment size for sampling from static lots or vehicles** 43
F.1 Introduction 43
F.2 Principle 43
F.3 Procedure 43

Annex G (normative) **Implementation of sampling plan from a material flow** 44
G.1 Introduction 44
G.2 Principle 44
G.3 Procedure verification of sampling aspects 44
G.4 Procedure: Mechanical or manual sampling from the drop flow 44
G.5 Procedure: Mechanical sampling from a moving conveyor 46
G.6 Procedure: Manual sampling from a stationary conveyor 47

Annex H (normative) **Implementation of the sampling plan from a static lot or vehicle** 49
H.1 Introduction 49
H.2 Principle 49
H.3 Procedure 49
H.4 Implementation of sampling in locations chosen in a stratified random way 50

Annex I (normative) **Minimum sample size required for analysis** 51
I.1 Introduction 51
I.2 Principle 51
I.3 Procedure 51

Annex J (normative) **Standard sampling plans for common situations** 56
J.1 Introduction 56
J.2 Sampling of granular SRF <25 mm from a moving conveyor 56
J.3 Sampling of granular SRF <25 mm from a static lot 59
J.4 Sampling of granular SRF <25 mm from a vehicle 62

Annex K (informative) **Additional information about precision** 66
K.1 Introduction 66
K.2 Scope 66
K.3 Trueness 66
K.4 Repeatability and reproducibility 66
K.5 Robustness 67

Annex L (informative) **Distribution of increments** 69
L.1 Scope 69
L.2 Stratified sampling 69
L.3 Stratified random sampling 70

Bibliography 72

Foreword

This document (EN 15442:2011) has been prepared by Technical Committee CEN/TC 343 “Solid recovered fuels”, the secretariat of which is held by SFS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2011, and conflicting national standards shall be withdrawn at the latest by September 2011.

This document supersedes CEN/TS 15442:2006.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document is one of a series of European Standards dealing with solid recovered fuel.

EN 15442, *Solid recovered fuels — Methods for sampling.*

EN 15443, *Solid recovered fuels — Methods for the preparation of the laboratory sample.*

EN 15413[1)], *Solid recovered fuels — Methods for the preparation of the test sample from the laboratory sample.*

This document differs from CEN/TS 15442:2006 mainly as follows:

a) results of interlaboratory tests supplemented as an informative Annex F;

b) whole document editorially revised.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

[1)] To be published.

Introduction

The testing of solid recovered fuel enables informed decisions about their subsequent handling and use. In order to carry out a test on a solid recovered fuel a sample of the material is required. Before any sampling operation is devised it is important that the objectives for sampling are clearly identified and subsequently well executed to ensure that the expectations of any involved parties are recognized and satisfied. The identification of objectives helps to define the level of testing required, e.g. thorough examination or routine testing and in addition desired reliability of testing / assessment and frequency of testing. The sampling objectives, along with the sequence of operations required to fulfill them are detailed in an overall sampling plan. After a sampling plan has been prepared the sampling of solid recovered fuels (SRF's) itself can be implemented.

Figure 1 shows the links between the essential elements of a testing program.

Sampling procedures are provided for a range of process streams and common storage conditions. The sampling technique adopted depends on a combination of different characteristics of the material and circumstances encountered at the sampling location. The determining factors are:

- the type of solid recovered fuel;
- the situation at the sampling location / the way in which the material occurs (e.g. in a stockpile, on a conveyor belt, in a lorry);
- the (expected) degree of heterogeneity (e.g. monostreams, mixed fuels, blended fuels).

This European Standard is primarily geared toward laboratories, producers, suppliers and purchasers of solid recovered fuels, but is also useful for the authorities and inspection organizations.

Standards for sampling of solid biofuels are available from Technical Committee CEN/TC 335 “Solid biofuels” CEN/TR 14589:2003, CEN/TR 15018:2005 and CEN/TR 15310:2006 for the sampling for the purpose of the characterization of waste are available from CEN/TC 292.

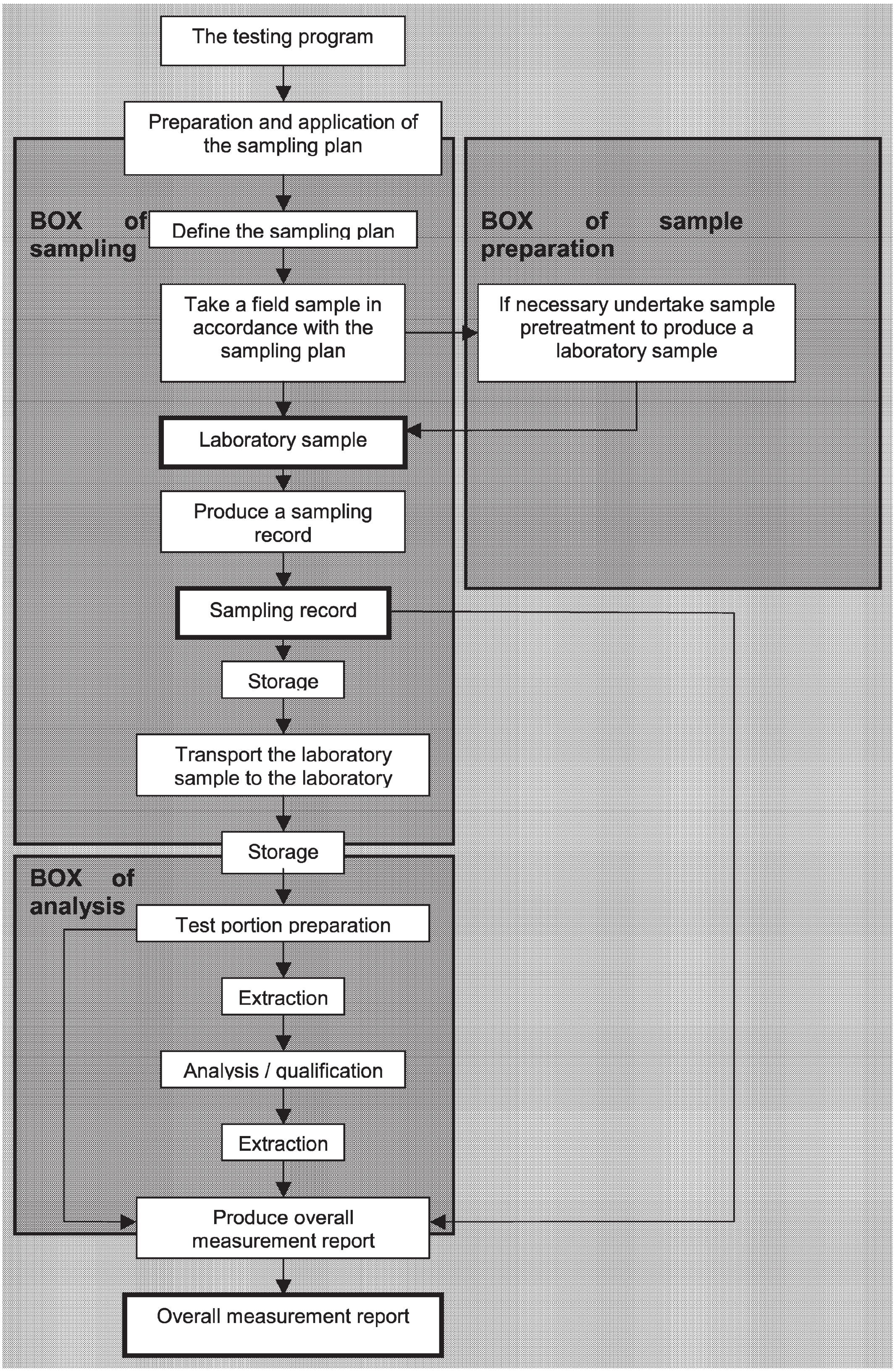

Figure 1 — Links between the essential elements of a testing program

1 Scope

This European Standard specifies methods for taking samples of solid recovered fuels for example from production plants, from deliveries or from stock. It includes manual and mechanical methods.

It is not applicable to solid recovered fuels that are formed by liquid or sludge, but it includes dewatered sludge.

2 Normative references

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

EN 15357:2011, *Solid recovered fuels — Terminology, definitions and descriptions*

CEN/TS 15401:2010, *Solid recovered fuels — Determination of bulk density*

EN 15413[2], *Solid recovered fuels — Methods for the preparation of the test sample from the laboratory sample*

EN 15415-1[2], *Solid recovered fuels — Determination of particle size distribution — Part 1: Screen method for small dimension particles*

EN 15443, *Solid recovered fuels — Methods for the preparation of the laboratory sample*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15357:2011 and the following apply.

3.1
coefficient of variation
estimate of the standard deviation of a population from a sample of n results divided by the mean of that sample. Frequently stated as a percentage

NOTE Adapted from Eurachem/Citac Guide CG 4 [26].

3.2
duplicate sample
two samples taken under comparable conditions, whereby this selection can be accomplished by taking units adjacent in time or space

NOTE 1 Although the replicate samples are expected to be identical, often the only thing replicated is the act of taking the physical sample.

NOTE 2 A duplicate sample is a replicate sample consisting of two portions.

NOTE 3 The replicate sample is usually used to estimate sample variability.

3.3
effective increment size
minimum sample size divided by the number of increments

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[2] To be published.

NOTE The effective increment size should never be smaller than the minimum increment size.

3.4
effective sample size
effective increment size multiplied by the number of increments

NOTE The effective sample size should never be smaller than the minimum sample size.

3.5
granular
more or less spherical or cubic

3.6
heterogeneity
degree to which a property or type of particle of a solid recovered fuel component is not uniformly distributed throughout a quantity of material

3.7
homogeneity
degree to which a property or a type of particle of a solid recovered fuel component is uniformly distributed throughout a quantity of material

3.8
increment
portion of fuel extracted in a single operation of the sampling device

3.9
lot
defined quantity of fuel for which the quality is to be determined

3.10
minimum increment size
minimum dimension or size of the increment that is taken from a lot, from the point of view of preserving its representativeness

NOTE The product of the minimum increment size and the number of increments to be taken should never be smaller than the minimum sample size.

3.11
minimum sample size
minimum sample size or dimension of the sample required during sampling and sample preparation from the point of view of preserving its representativeness

NOTE The minimum sample size is equal to the effective increment size multiplied by the number of increments, and is linked directly to the nominal top size.

3.12
nominal top size
d_{95}
aperture size of the sieve used for determining the particle size distribution of solid fuels through which at least 95 % by mass of the material passes

3.13
precision
closeness of agreement between independent test/measurement results obtained under stipulated conditions

NOTE 1 Precision depends only on the distribution of random errors and does not relate to the true value or the specified value.

NOTE 2 The measure of precision is usually expressed in terms of imprecision and computed as a standard deviation of the test results or measurement results. Less precision is reflected by a larger standard deviation.

NOTE 3 Quantitative measures of precision depend critically on the stipulated conditions.

NOTE 4 Adapted from ISO 3534-2:2006.

3.14
random sampling
taking a sample at a random location within a specified range or from a specified lot. A random location is determined by lot

3.15
repeatability
precision under repeatability conditions

NOTE 1 Adapted from ISO 3534-2:2006.

NOTE 2 Repeatability can be expressed quantitatively in terms of the dispersion characteristics of the results.

3.16
reproducibility
precision under reproducibility conditions

NOTE 1 Adapted from ISO 3534-2:2006.

NOTE 2 Reproducibility can be expressed quantitatively in terms of the dispersion characteristics of the results.

NOTE 3 Results are usually understood to be corrected results.

3.17
sample
quantity of material, representative of a larger quantity for which the quality is to be determined

3.18
sample preparation
actions taken to obtain representative analysis samples or test portions from the original sample

3.19
sampling
process of drawing or constituting a sample

NOTE Adapted from ISO 3534-1:2006 [22].

3.20
sampling plan
predetermined procedure for the selection, withdrawal, preservation, transportation and preparation of the portions to be removed from a lot as a sample

NOTE Adapted from ISO 11074:2005 [23].

3.21
sampling record
report which serves as a check list and provides the investigator with all necessary information about the sampling techniques applied at the site and any additional important information

NOTE Adapted from ISO 11074:2005.

3.22
shape factor
factor that corrects the minimum sample size if the particles in a lot have not a regular shape (e.g. spherical or cubic)

3.23
static lot
lot that is not in motion during the sampling, or transported by a conveyor or alternative transport system

3.24
stratified sampling
sampling consisting of portions obtained from identified subparts (strata) of the parent population

3.25
stratified random sampling
sampling consisting of portions obtained from identified subparts (strata) of the parent population

NOTE Within each stratum, the samples are taken randomly.

3.26
test portion
sub-sample either of a laboratory sample or a test sample required for the specific measurement

3.27
trueness
closeness of agreement between the expectation of a test result or a measurement result and a true value

NOTE 1 Adapted from ISO 3534-2:2006.

NOTE 2 The measure of trueness is usually expressed in terms of bias.

NOTE 3 Trueness is sometimes referred to as “accuracy of the mean”. This usage is not recommended.

NOTE 4 In practice, the accepted reference value is substituted for the true value.

NOTE 5 The determination of the exact trueness for waste and from waste derived materials such as solid recovered fuels is by definition not possible.

4 Symbols and abbreviated terms

For the purposes of this document, the following symbols and abbreviated terms apply.

b	is the breadth of the flow, in m
cv	is the coefficient of variation
d_{05}	is the nominal minimum size (a mass fraction of 5 % of the particles are smaller than $\boldsymbol{d_{05}}$), in mm
d_{95}	is the nominal top size of a particle (a mass fraction of 95 % of the particles are smaller than $\boldsymbol{d_{95}}$), in mm
g	is the correction factor for distribution in the particle size
G	is the conveyor load, in kg/m
λ_{b}	is the bulk density of the solid recovered fuel, in kg/m^3
λ_{p}	is the particle density, in kg/m^3

m	is mass, in kg
n	is the number of increments to be taken per lot
p	is the fraction of the particles with a specific characteristic (such as a specific contaminant), in kg/kg, and is equal to 0,1
Φ_f	is the bulk density of the flow, in kg/m^3
Φ_d	is the drop flow, in kg/s
f	is the shape factor, in m^3/m^3
V	is volume, in m^3
v	is conveyor velocity, in m/s

5 Principle

Every particle in the lot or sub-lot to be represented by the sample should have an equal probability of being included in the sample. When this principle cannot be applied in practice, the sampler shall note the limitations in the sampling plan.

6 Development of a sampling plan

6.1 Principle

From a pre-defined lot of solid recovered fuel, samples shall be taken representatively on the basis of a sampling plan that shall be drawn up before the sampling takes place. Annex A specifies how this sampling plan shall be made. Annex J specifies simplified sampling plans for three common situations according to this clause and Annex A. Figure 2 determines whether a simplified sampling plan can be used.

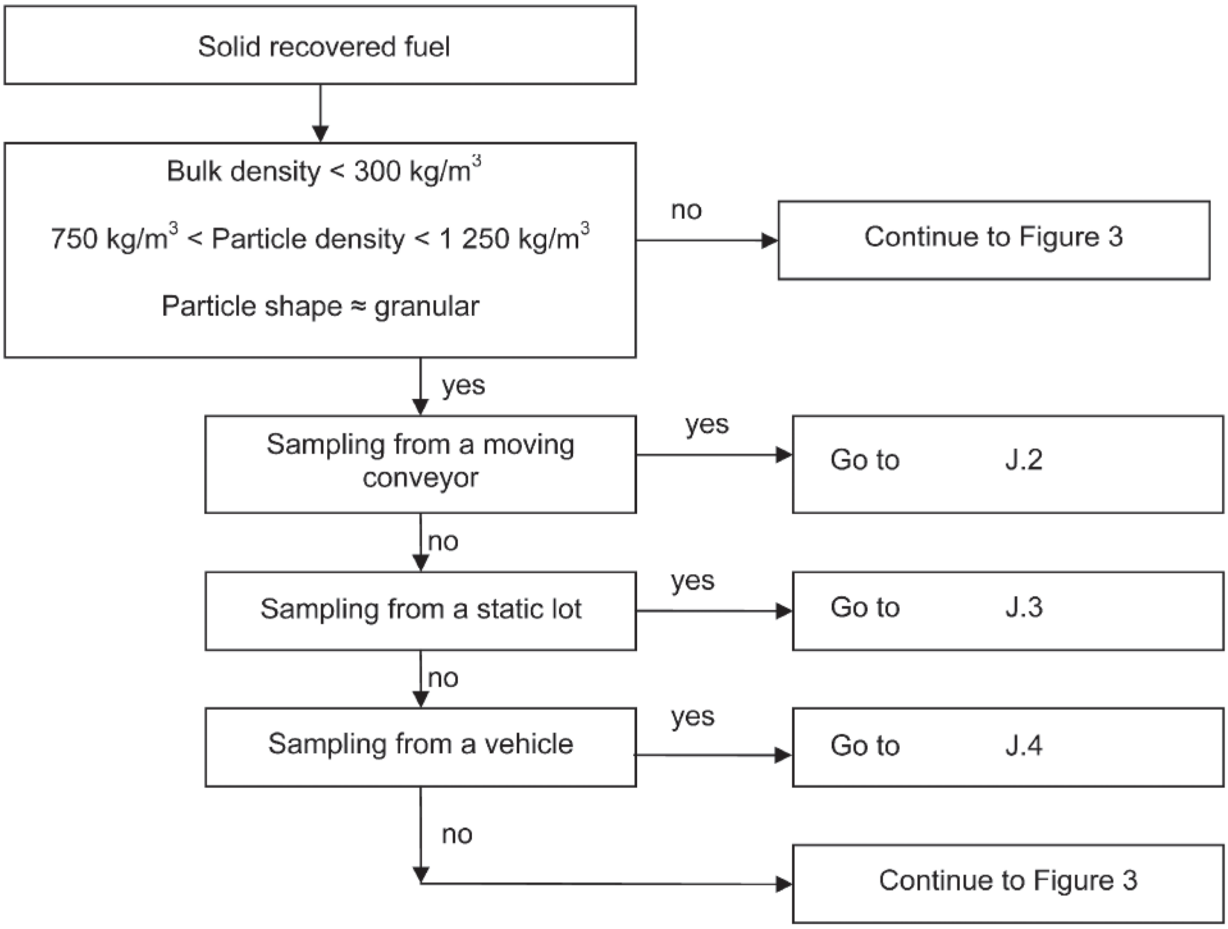


Figure 2 — Check for the standard sampling plan

The sampling plan shall be drawn up on the basis of the objective for the sampling process, using the available data on a solid recovered fuel and the accessibility of the lot, see Annex B. The sampling plan shall be completed. If certain estimates concerning specific parameters relating to the lot cannot be determined with sufficient certainty on the basis of the information available, these shall be verified in the field. If necessary, the sampling plan shall be adjusted in the field and the deviations shall be reported in the sampling record. Figure 3 shows the actions that are necessary for the development of a sampling plan.

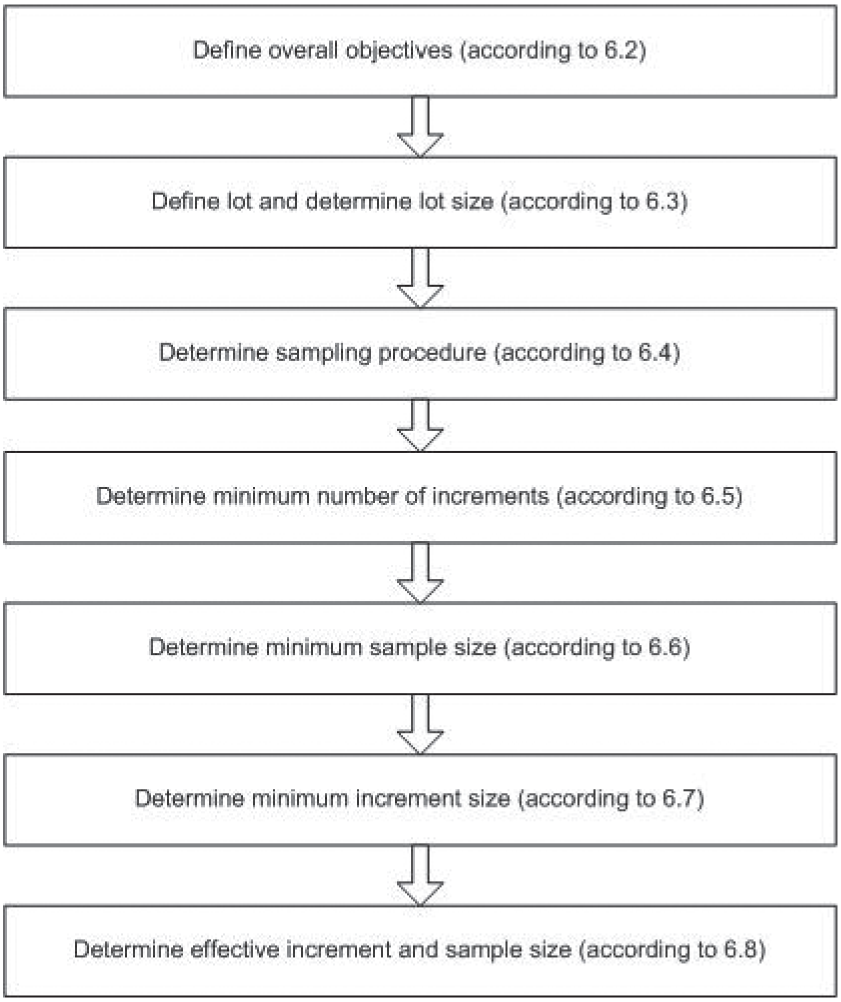


Figure 3 — Necessary elements for the development of a sampling plan

6.2 Definition of overall objectives

The sampling plan shall specify the objectives of the sampling program through consultation with all involved parties. These involved parties are e.g. the client, the producer of the solid recovered fuel, the sampler. The sampling plan shall specify the primary objectives of the sampling program. The sampling plan shall meet the requirements of objectives. If it is not possible to meet all requirements following the objectives for sampling in one single document sampling plan, two or more sampling plans shall be made in order to achieve adequate sampling plans for all objectives.

The sampling plan(s) shall identify any special precautions to be followed where the solid recovered fuel to be sampled is hazardous to human health.

6.3 Definition of a lot and determining lot size

6.3.1 General

The lot shall be defined on the basis of the way in which the material is or has been produced and/or is offered (upon delivery, upon acceptance, upon storage or in store, for instance). The lot size relates to a quantity of material delivered on the basis of one specification and production process. This material is agreed on by contract as a unit, and is identifiable as such. The maximum weight of a lot or sub-lot, for sampling purposes, shall be no more than $1,5 \times 10^6$ kg.

If the contracted lot weighs more than 1,5 × 10^6 kg it shall be split into two or more separate lots in order to maintain the lot size below or at the maximum lot size. The lot definitions in 6.3.2 to 6.3.5 are possible:

6.3.2 Definition of a lot in case sampling from a material flow

The lot shall be either defined as a period of production or as the period in which a certain amount of solid recovered fuel is transported through the material flow.

6.3.3 Definition of a lot in case of transport by a vehicle

The total lot shall compromise the contents of the entire series of 1 or more vehicles used to transport the lot. A vehicle can be both a lorry or a (railway) truck.

6.3.4 Definition of a lot in case of transport by ship

The total lot shall compromise to the contents of the entire series of 1 or more ships used to transport the lot. If the ship contains more than 1,5 × 10^6 kg the ship shall be divided in such a number of sub-lots that the size of a sub-lot is no more than 1,5 × 10^6 kg.

If one ship contains several lots (in other words, quantities of material that differ from each other with regard to the specifications agreed on in a contract with the producer of the material beforehand), these lots shall be stored in separate compartments in the ship. In that case, a lot relates to the quantity of material that is transported and delivered by separate compartments.

6.3.5 Definition of a lot in case of sampling from a static lot

If the material has been stored at the producer's or purchaser's premises in a (temporary) store, the (static) lot relates to the quantity of material with the specifications agreed on beforehand in a contract within a demarcated area.

6.4 Determination of the sampling procedure

The sampling method that shall be used shall be representative. Therefore, the material shall preferably be sampled from a moving transport medium. Various sampling methods exist. In the list below these methods are shown in the order of preference in which the methods shall be used. The representativeness decreases as you go down the list. You shall only choose a less representative method if a more representative one is not possible in the existing situation.

a) mechanically from a drop flow. The method specified in G.4 shall be used for this situation;

b) mechanically from a moving conveyor. The method specified in G.5 shall be used for this situation;

c) manually from a stationary conveyor. The method specified in G.6 shall be used for this situation;

d) manually from a drop flow. The method specified in G.4 shall be used for this situation;

e) manually from a vehicle. The method specified in Annex H shall be used for this situation;

f) from a (temporary) store. The method specified in Annex H shall be used for this situation.

6.5 Determination of the number of increments

The minimum number of increments shall be 24. This means that for a lot size of 120 tons on the average every 5 tons an increment has to be taken. For a lot size of 1 320 tons this means that on the average every 51 tons an increments needs to be taken.

It is possible to take more increments. Reasons for taking more increments can be:

- if more sample material is required;
- if it is easier to stratify the lot in different number of strata e.g. 5 by 5 = 25 strata.

6.6 Determination of minimum sample size

In Annex D it is specified how the minimum sample size shall be determined.

6.7 Determination of the minimum increment size

6.7.1 Determination of minimum increment size for material flows

If samples are taken from a material flow or from a conveyor, the minimum increment size shall be determined using the instructions in Annex E, in which a distinction is made between the following situations for the purposes of determining the minimum increment size:

- mechanical and manual sampling from a drop flow;
- sampling from a conveyor. Here, for the purposes of determining the minimum increment size, no distinction is made between mechanical sampling from a moving conveyor and manual sampling from a stationary conveyor.

6.7.2 Determination of the minimum increment size for static lots or vehicle

If samples are taken from static lots or vehicles (lorry, truck or ship), the minimum increment size shall be determined using the instructions in Annex F.

6.8 Determination of the effective increment and sample sizes

6.8.1 Determination of the effective increment size

The effective increment size shall meet the three requirements below:

- the effective increment size shall be at least as large as the minimum increment size;
- the effective increment size shall be large enough in order to obtain a sample of the minimum sample size with the selected number of increments;
- the effective increment size shall be large enough in order to obtain a sample sufficiently large enough for the analysis in the laboratory.

6.8.2 Determination of the effective sample size

The effective sample size shall meet the three requirements below:

- the effective sample size shall be at least as large as the minimum sample size;
- the effective sample size shall be large enough in order to equal at least the minimum increment size multiplied by the number of increments;
- the effective sample size shall be large enough for the analysis in the laboratory.

Only if the nominal top size is more than 40 mm the effective sample size may be reduced in order to downscale the sample size to realistic proportions. The reduction of the particle size and the sample size shall be done according to EN 15443, but the sampling report and the analyses report shall clearly mention this deviation and state that therefore the testing results are less representative.

6.9 Selection of distribution of increments over a lot

6.9.1 General

The increments shall be taken scattered all over the lot. Each particle in the lot shall have an equal chance of ending up in the sample. The following sampling methods (arranged in decreasing order of preference) shall be used:

a) stratified random sampling;

b) stratified sampling.

“Stratified” means that a quantity of material (expressed as a mass or volume) or a time interval is divided into a specific number of equal strata (sections). Examples of sampling for clarification are shown in Annex L.

6.9.2 Determination of the distribution of the increments when sampling from a material flow

If the sampling is planned from a material flow, the time when each increment is to be sampled shall be determined. This requires the following approach:

a) the lot shall be either defined as a period of production or as the period in which a certain amount of solid recovered fuel is transported through the material flow;

b) this period shall be divided by the number increments in order to obtain equal strata (sub periods) for each increment;

c) the exact time within each stratum shall be determined either random or fixed in the middle of the period.

6.9.3 Determination of the distribution of the increments when sampling from a vehicle(s)

If the sampling is planned from a vehicle, the locations in the vehicle(s) shall be determined. This requires the following approach:

a) the lot shall be defined as a number of vehicles with a minimum of one vehicle;

b) from each vehicle the same number of increments shall be taken;

c) the number of increments per vehicle multiplied by number of vehicle shall at least the minimum number of increments;

d) if it is possible and sufficiently safe for the sampler to do so, this increment may be taken directly from the vehicle. If this is not possible, the increment may be taken directly after the material has been unloaded in accordance with the system for sampling from a material flow (6.9.2) or from a static lot (6.9.4);

e) for each vehicle selected, take the increments from the top, middle and bottom of the material alternately, i.e. increment 1 from the top of the material in the first vehicle selected, increment 2 from the middle of the material in the second vehicle selected, increment 3 from the bottom of the material in the third vehicle selected, and so on.

The sampling shall be implemented by performing the complete sampling plan.

EXAMPLE 1 A lot of 3 × 10^6 kg solid recovered fuels consisting of pellets, will be transported to a purchaser by a total of 120 lorries, with an average load of 25 000 kg per lorry. The maximum lot size is 1,5 × 10^6 kg. The quantity above the maximum permitted lot size should be regarded, for sampling purposes, as a new lot or sub-lot. The total lot of 3 × 10^6 kg is therefore split into two separate sub-lots for sampling of 1,5 × 10^6 kg each. For each sub-lot of 1,5×10^6 kg, the minimum number of increments that are taken is 24. Sampling requires the following approach:

Step 1) The weight of the total lot is 3 × 10^6 kg. For sampling purposes, this is regarded as two sub-lots weighing 1,5×10^6 kg each. The first sub-lot will be transported by a series of 60 lorries;

Step 2) At least 24 increments should be taken for each sub-lot of 1,5 × 10^6 kg, but because 30 increments is easier regarding the number of 60 lorries it is decided that 30 increments will be taken. Therefore from the first sub-series and then from every consecutive sub-series of 60/30 = two lorries, a lorry is selected for sampling in a (preferably) random way each time. For example, from the first sub-series (lorry 1 – lorry 2), lorry number 1 is sampled, from the second sub-series (lorry 3 – lorry 4) lorry number 4 is sampled, from the third sub-series (lorry 5 – lorry 6) lorry number 5 is sampled, and so on;

Step 3) The increment should be taken randomly from the top of the material in lorry number 1, from the middle of the material in lorry number 4, from the bottom of the material in lorry number 5, and so on. The dimensions of each increment shall be at least equal to the already determined minimum or effective increment size.

Steps 1 to 3 shall be completed again for the sampling process involving the second sub-lot of 1,5 × 10^6 kg.

NOTE 1 If for example 2 increments should be taken from each of the lorry, it would be very useful to take one increment at the beginning of unloading of the lorry (short stop during loading) and the second increment at the middle/end of unloading the lorry in accordance with the system for sampling from a material flow (6.9.2) or static lot (6.9.4).

NOTE 2 If the dimensions of a lot are such that the number of vehicles used to transport the lot is equal to or less than the (minimum) number of required increments, at least two (or more when necessary) increments should be taken per vehicle.

6.9.4 Implementation of sampling from a static lot

Implementation of sampling from a static lot or store requires the following approach:

a) determine the dimensions of the lot or store;

b) divide the lot or store into as many strata of equal dimensions as the number of increments to be taken;

c) for each stratum, determine in a (preferably) random way the location where the increments will be taken;

d) for each location, take the increments from the top, middle and bottom of the material alternately.

The sampling shall be implemented by performing the complete sampling plan.

EXAMPLE 2 A lot of solid recovered fuel of 1 × 10^6 kg, which shall be sampled, has a volume of 3 000 m^3. The lot is 60 m long, 40 m wide and 1,25 m high. Twenty-four increments are taken from the lot. The following approach is used for the sampling process:

1) the surface area of the lot is 2 400 m^2, and the number of increments to be taken is 24. The lot can therefore be divided into 24 sections of 10 m by 10 m (100 m^2);

2) for each stratum of 100 m^2, the increment location is determined (the x and y values) in a random way and one increment is taken;

3) for each location drawn, take the increments from the top, middle and bottom of the material alternately, i.e. increment 1 from the top of the material within stratum 1, increment 2 from the middle of the material within stratum 2, increment 3 from the bottom of the material within stratum 3, and so on.

7 Implementation of the sampling plan

7.1 Steps before actual sampling

The following things shall be performed by the sampler before the actual sampling:

a) control of all relevant data in the sampling plan;

b) control of the nominal top size. If the nominal top size is larger than stated in the sampling plan, the project leader shall be notified and a new effective sample and increment size shall determined and mentioned at deviations;

c) control of the lot size. If the lot size is deviating from the sampling plan it shall be adjusted;

d) control whether the lot appears to be one lot and does not origin from two or more different lots. Make sure the lot does not origin from two or more different lots. If the lot origin is from more than one lot, each lot shall be sampled separately;

e) make a situation sketch or pictures from different angles;

f) if steps a) to e) require adjustments of the sampling plan these shall be reported in the sampling report and sufficiently justified.

7.2 Steps during sampling

The following things shall be performed during sampling:

a) if sample is taken manually it is important that the increment is taken in one movement and that no material is removed from the increment after it is taken. In case the size of an increment is too large a new increment shall be taken;

b) the sampler shall not judge the quality of an increment nor discard it and shall not take a new one if he thinks the increment is not representative. This will influence the representativeness of the sample. In every case the upper surface of the material to be sampled shall always be removed to avoid material that has dried and/or become contaminated;

c) if during the performance of the sampling anything is performed deviating from the sampling plan this shall be mentioned in the sampling report in the section for deviations. The deviations shall be sufficiently motivated.

7.3 Steps after sampling

The following things shall be done after sampling:

a) the sampling plan shall be finished by the sampler;

b) the sampling containers shall be closed and sufficiently labelled.

8 Handling and storage of samples

The sampling plan shall identify the procedure(s) selected for packaging, preservation, storage, and transport of the laboratory sample. The samples shall be kept in a dry cooled space, in tightly sealed packaging. If the dimensions of the (sub-)samples are larger than 1 m^3, they should be kept in a cold and dry room preferably covered. The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material. Samples that are stored shall be pre-dried according to EN 15443.

Samples containing more than 15 % moisture by weight shall be stored for a maximum of one week at maximum 5 °C. If longer time for storing is required samples have to be pre-dried to avoid problems with moisture (drying effect and micro-organisms decomposing the sample).

9 Precision

The tests results for a measurement on solid recovered fuels are usually applied for the enforcement of regulation or for contract execution. In such legal situations it is vital that the associated uncertainties for the tests results are known.

Data regarding the uncertainty of this European Standard has been acquired through the validation investigation QUOVADIS. The results of QUOVADIS give information on the uncertainty of the sampling method.

Two reasons cause that these results of QUOVADIS cannot be available as normative data on the precision of the sampling:

1) the trueness of a measurement regarding solid recovered fuel is by definition not available, because knowledge on the true composition of solid recovered fuel is by definition unknown;

2) validation data shall be available for each specific matrix and therefore each type of solid recovered fuel.

Therefore, data on the precision of the method for sampling of solid recovered fuels is only shown in Annex K.

Annex A
(normative)

Procedure for the development of a sampling plan

A.1 Introduction

This annex specifies a procedure for the development of a sampling plan.

A.2 Principle

In A.3 a procedure for the development of sampling plan specifies in 9 parts with 27 steps how a sampling plan shall be made.

A.3 Procedure

Part 1 Defining lot and lot size

1) What form does the solid recovered fuel take (fluff, pellets, bales, powder…)? Make a note.
2) Which company has the lot of solid recovered fuel come from? Make a note.
3) What are the estimated dimensions of the lot or sub-lot? Make a note.

Part 2 Gathering information on the sampling location and possible sampling procedure

4) During the installation, is there any facility for taking samples mechanically from the drop flow, or can such a facility be realized? If so, make a note and go to step 9.
5) During the installation, is there any facility for taking samples mechanically from the conveyor belt, or can such a facility be realized? If so, make a note and go to step 9.
6) During the installation, is there any facility for taking samples manually from a stationary conveyor belt, from the drop flow, or can such a facility be realized? If so, make a note and go to step 9.
7) During the installation, is there any facility for taking samples manually from the drop flow? If so, make a note and go to step 9.
8) Is there any facility for taking samples manually from a vehicle? If so, make a note and go to step 9. If not, take a sample of the solid recovered fuel from a static lot, and go to step 9.

Part 3 Gathering information on the solid recovered fuel

9) What components does the solid recovered fuel consist of (plastics, paper, wood, organic material, sand…), and what is the nominal top size of these components? The producer’s data can be used for this. Make a note.
10) What is the dominant shape of the particles with the nominal top size (flat pieces or more or less granular)? Make a note.
11) What is the bulk density of the solid recovered fuel? Make a note.

12) What is the average particle density of the components of the solid recovered fuel? Make a note.

Part 4 Determination of increment and sample size

13) Using the data from part 1, 2 and 3, determine the minimum and effective increment sizes in kg and l. Make a note. Clearly write down when any deviations occur.

14) Using the data from part 1, 2 and 3, determine the minimum and effective sample sizes, and ascertain using the data from Annex I, whether or not this sample size is sufficient for the required analyses, any reserve samples, duplicate samples or countercheck samples. Make a note. Clearly write down when any deviations occur.

Part 5 Determination of the number of increments to be taken and the times or locations of the increments

15) For sampling from a material flow, go to part 6. For sampling from a vehicle, go to part 7. For sampling from a static lot, go to part 8.

Part 6 Sampling from a material flow

16) Determine how much time is needed to transport a lot, or the defined duration of the lot size.

17) Divide this time into equal time intervals, so that one time interval is available for each increment.

18) Determine the sampling time for each time intervals, preferably in a random way.

19) Go to part 9 for the instruction how to store the sample.

Part 7 Sampling from a vehicle

20) Determine, preferably in a stratified random way, which units of vehicles from the entire series of vehicles (which contain the entire lot) qualify for sampling. Determination in a stratified random way is explained in L.3.

21) Take at least one increment from each vehicle selected for the sampling process. If it is possible and sufficiently safe for the sampler, this increment may be taken directly from the vehicle. If this is not possible, the increment may be taken directly after the material has been unloaded, in accordance with the system for sampling from a material flow (part 6), or from a static lot (part 8).

22) For each vehicle selected, take the increments from the top, middle and bottom of the material alternately, i.e. increment 1 from the top of the material in the first vehicle selected, increment 2 from the middle of the material in the second vehicle selected, increment 3 from the bottom of the material in the third vehicle selected, and so on.

23) Go to part 9 for the instruction how to store the sample.

Part 8 Sampling from a static lot

24) Determine the dimensions of the static lot, and then divide the lot logically into a number of sections, so that for each increment required, there is one section available.

25) For each stratum, randomly draw the location where the increments will be taken, and then, for each location drawn, take the increments from the top, middle and bottom of the material alternately.

26) Go to part 9 for the instruction how to store the sample.

Part 9 Storing sample

27) The samples shall be wrapped and kept in tightly sealed packaging. The samples shall not be exposed to sunlight. The sampling container shall therefore not be transparent. If the size of samples is too large, they may be kept in a dark and dry room. If samples are stored for more than three days they shall be pre-dried in order to prevent changes to the sample due to biological activity.

Annex B
(informative)

Guideline for a sampling plan

B.1 Introduction

This annex specifies how a form for sampling plan can be made.

B.2 Form for the sampling plan

1) General information

Project (number)		
Name of project leader Telephone		
Name of sampler and company Telephone		
Sampling date		
Sampling location Street Town/city		
Contact on site Telephone		
Description of material for sampling		
Measurement objective		The objective is the reason why a sample is taken.

2) Definition of lot and lot size

Form taken by solid recovered fuel		(follows from step 1)
Origin of solid recovered fuel		(follows from step 2)
Lot size dimension	kg m^3	(follows from step 3) Take care the lot size can also be determined as the tonnage from a certain period of transport or production if sampling from a material flow.

3) Information on sampling location and possible sampling procedure

Which ideal sampling procedure is possible?	☐ mechanical sampling from the drop flow ☐ mechanical sampling from the conveyor belt ☐ manual sampling from the conveyor belt ☐ sampling from one or more vehicles ☐ sampling from a static lot	(follows from step 4 to step 8)

4) Information on solid recovered fuel

Bulk components		(follows from step 9)
Nominal top size	mm	(follows from step 9)
Dominant shape of particles with nominal top size		(follows from step 10)
Bulk density	kg/m^3	(follows from step 11)
Particle density	kg/m^3	(follows from step 12)

5) Information on increment and sample sizes

What is the minimum increment size?	- kg - l	(follows from step 13)
What is the minimum sample size?	- kg - l	(follows from step 14)
What is the effective increment size?	- kg l	(follows from step 13)
What is the effective sample size?	- kg l	(follows from step 14)

6) Number of increments to be taken, and the times or locations of the increments

How many increments are required?		(follows from step 15)		
Increments	Times (follow from steps 17 to 19)	Divide the lot into as many sections as the number of increments required. An increment is taken from each section, preferably in a random way (see steps 20 to 24).		
		X coordinate	Y coordinate	Z coordinate
Increment number 1	- ….. h and ….. min			
Increment number 2	- ….. h and ….. min			
Increment number 3	- ….. h and ….. min			
Increment number 4	- ….. h and ….. min			
Increment number 5	- ….. h and ….. min			
Increment number 6	- ….. h and ….. min			
Increment number 7	- ….. h and ….. min			
Increment number 8	- ….. h and ….. min			
Increment number 9	- ….. h and ….. min			
Increment number 10	- ….. h and ….. min			
Increment number …	- ….. h and ….. min			
Increment number …	- ….. h and ….. min			

7) Storage

Nominal top size >> 30 mm	☐ No. If possible, decrease the size of each sample to the minimum sample size for the d_{95} concerned. ☐ Yes. If possible, reduce the particles of the sample to a d_{95} of approximately 30 mm or less, and decrease the size of the sample to the minimum sample size for the d_{95} concerned [a].	(follows from step 25)
The samples shall be kept in a dry room, in tightly sealed packaging. If the size of the (sub-)samples are too large, they may be kept in a dry room. [a] The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material.		

8) Deviations detected

All deviations regarding this European Standard introduced in the sampling plan shall be reported and sufficiently justified. All deviations regarding the sampling plan encountered in the field operation shall be reported and sufficiently justified. **If sufficiently motivated mentioning deviations is a sign of quality.**

9) Approval of sampling plan and sampling record

	Name	Signature	Date
Project leader			
Sampler			

Appendices

1. Calculating increment and sample sizes
2. Photos of the location/position of random check lots/sampling
3. ………………………………………

Annex C
(normative)

Sampling equipment and implements

C.1 Introduction

This annex specifies which requirements the sampling equipment will have to meet.

C.2 Principle

The equipment used to carry out the sampling shall not affect the composition of the solid recovered fuel (SRF) and every particle shall have an equal chance of being captured in the increment.

C.3 Selection of an apparatus

The range of equipment which is available for sampling of SRF (and other materials) is very large. Depending on the situation many different types of sampling equipment are possible, but they shall meet the three basic rules for sampling. These are rules are:

a) the sampling equipment shall not contaminate or affect the sample taken from the solid recovered fuel;

b) every particle should have an equal chance of being sampled;

c) the minimum dimensions of the sampling equipment shall be at least three times the nominal top of the particles in the solid recovered fuel.

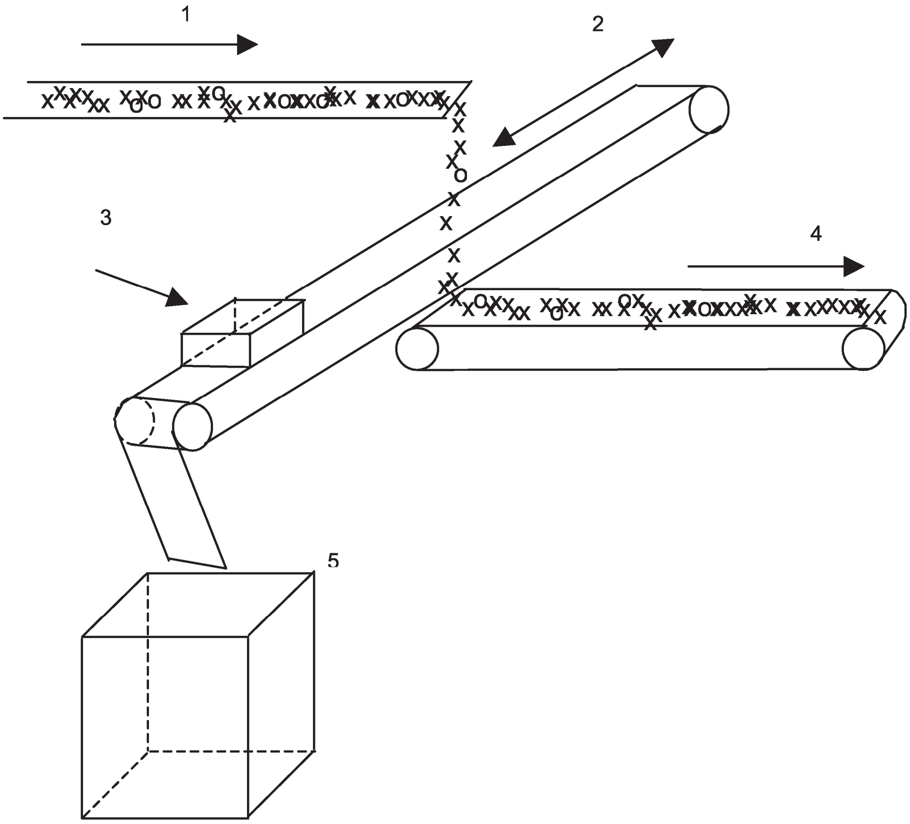
When choosing an implement or piece of equipment, it is essential to take the procedure that will be used for sampling into account.

C.4 Examples for sampling from a moving conveyor or drop flow

In this subclause a number of examples of equipment for sampling from a moving conveyor or a drop flow are given. If other systems are used, the three basic rules as mentioned in C.3 for taking an increment shall be met. This requires that the whole stream should be covered.

Common designs of equipment are the following:

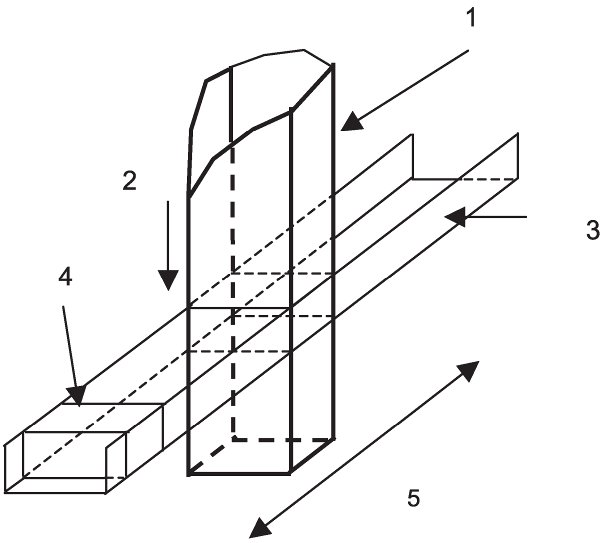
- a tray that moves through the drop flow via rail, motorised or otherwise (rail tray method, see Figure C.1);
- a tray that is pulled like a drawer through a drop flow (drawer method, see Figure C.2);
- a scoop or a flap which may or may not be mechanically driven, which is placed in the drop flow at the sampling time. The scope or flap shall pass completely through the stream depth and cover its full width when collecting without overfilling;
- a cross-belt sampler is an automatic device which enables sampling from a moving conveyor belt (see Figure C.3).



Key

1 direction of motion of solid recovered fuel
2 direction of motion of the collection tray
3 moving collection tray
4 direction of motion of solid recovered fuel
5 sample collection tray

Figure C.1 — Rail tray method



Key

1 chute of solid recovered fuels
2 direction of drop
3 moving rail for the collection tray
4 sliding tray
5 direction of motion of collection tray

Figure C.2 — Drawer method

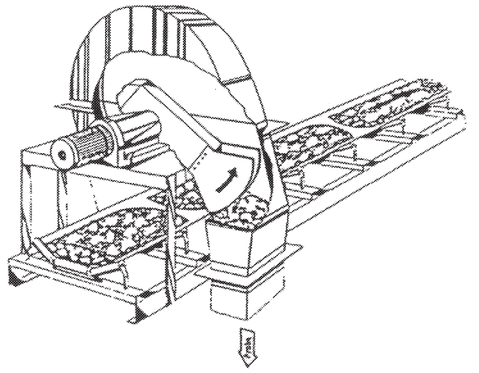


Figure C.3 — An example of a cross-belt sampler

C.5 Sampling frame

A sampling frame shall be used if sampling is performed manually from a stationary conveyor. The sampling frame is placed on the stationary transport flow with a distance between the two side plates of at least three times the nominal top size. Figure C.4 is a schematic drawing of a sampling frame.

If fluff-type solid recovered fuels are being sampled and the material is being transported from left to right, any material that lies partly on the left of the left plate (after the increment has been taken) is counted as part of the increment. Any material that lies partly on the right of the right plate when the increment is being taken is not counted as part of the increment. If granular solid recovered fuels are being sampled, all the material that lies between the two plates is counted as part of the increment. If there is any doubt, the same applies as for fluff-type material.

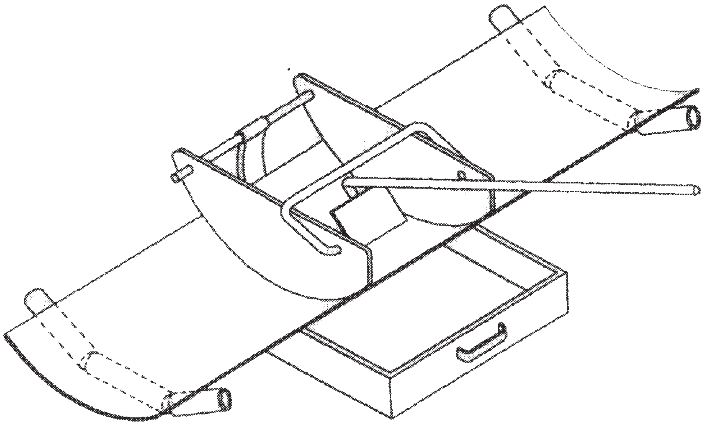


Figure C.4 — Sampling frame

C.6 Sampling scoop

The equipment which can be used for manually sampling from a temporary static lot or vehicle is a special sampling scoop. Other equipment can be used as well, but they have to meet the three basic rules for sampling equipment mentioned in C.3. The breadth, length and height of the scoop for granular solid recovered fuels shall be at least three times the nominal top size d_{95}. Figure C.5 shows a scoop which has been designed for granular SRF. Figure C.6 shows a scoop which has been designed for fluff.

Example 1 shows how the required dimensions shall be determined for a sampling scoop that is used for granular solid recovered fuels. Example 2 shows the same for fluff-type solid recovered fuels.

EXAMPLE 1

For a granular solid recovered fuel with a d_{95} of 20 mm, the minimum dimensions ($l \times b \times h$) of the sampling scoop is 60 mm × 60 mm × 60 mm. A sampling scoop like the one illustrated in Figure C.5 can be used for type of solid recovered fuel.

EXAMPLE 2

For a solid recovered fuel, which consist almost entirely of flat parts, the dimensions of the sampling scoop shall be at least equal to 3 times $d_{95,l}$, where

— $d_{95,l}$ is the maximum length of a fluff particle (a mass fraction of 95 % of the particles are smaller than d_{95l}).

Therefore, for fluff with a $d_{95,l}$ of 200 mm, the dimensions of the sampling scoop ($l \times b \times h$) shall be at least 600 mm × 600 mm × 600 mm. For sampling fluff-type solid recovered fuels it is advisable to use a sampling scoop that has a sharp point underneath and upright walls (see Figure C.6).

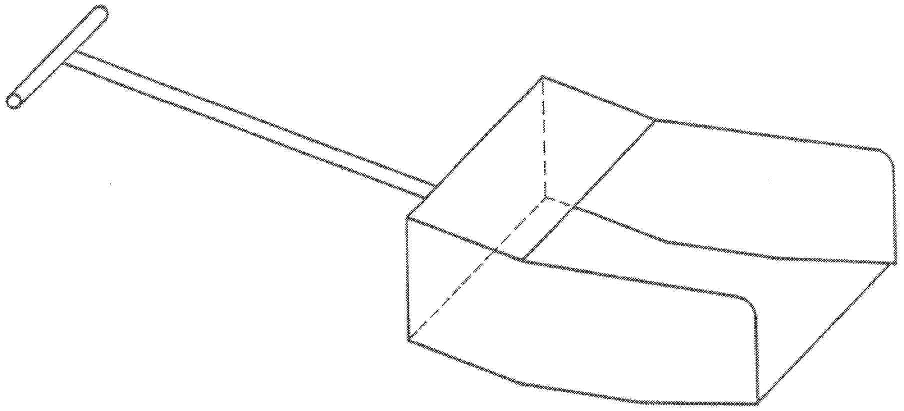


Figure C.5 — Schematic design of sampling scoop for granular solid recovered fuels

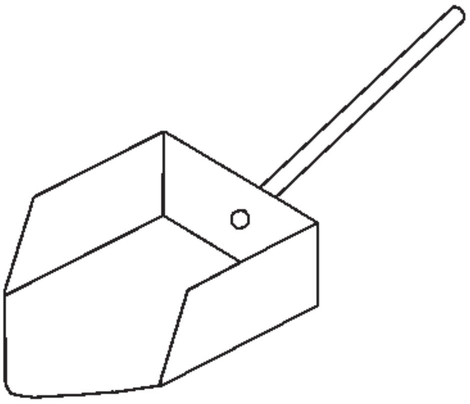
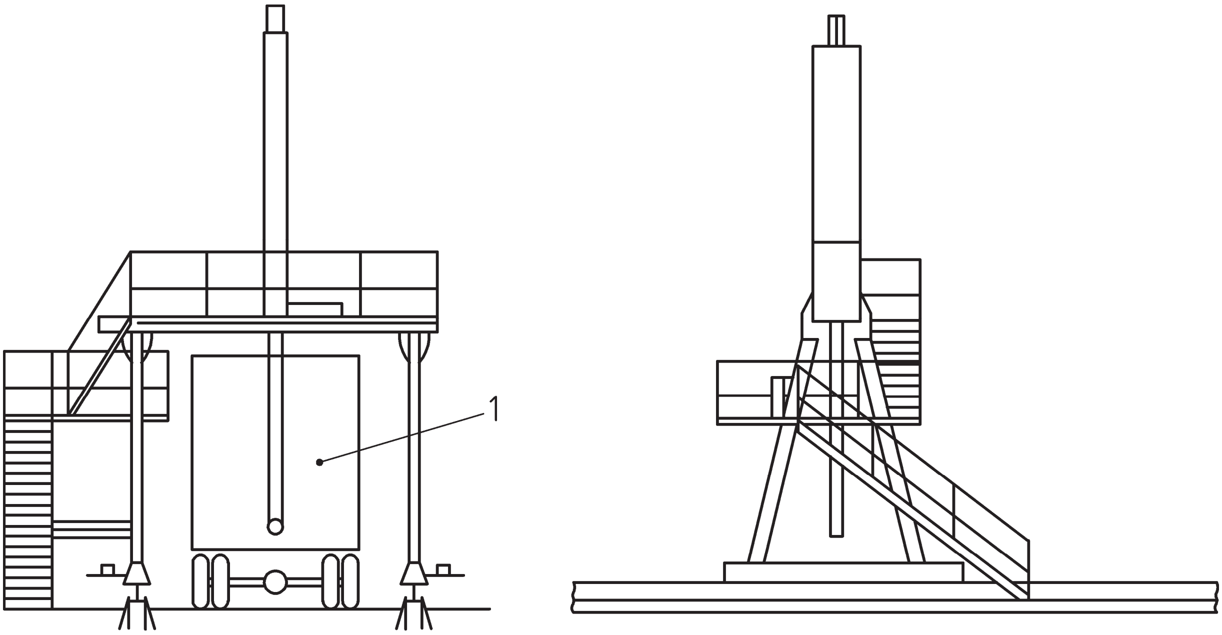


Figure C.6 — Schematic design of sampling scoop for fluff-type solid recovered fuels

C.7 Mechanical probe

Mechanical systems can be used for sampling from lorries or railway wagons. Figure C.7 shows an example of a mechanical probe. Mechanical probes are suitable for materials with a nominal top size less than 25 mm. The system shall be designed to prevent loss of moisture during sampling. The internal diameter of the drill shall be at least three times the nominal top size of the material to be sampled. The instructions for the use of the equipment provided by the manufacturer shall be followed if in accordance with the principles of this European Standard. Choose the sampling points, and the depth from which each increment is taken, randomly. The mechanical probes provided with a drill may cause a size reduction of coarse materials and shall not be used for determination of the particle distribution of the nominal top size.



Key

1 lorry

Figure C.7 — An example of a mechanical probe

Annex D
(normative)

Determination of minimum sample size

D.1 Introduction

This annex specifies how the minimum sample size shall be determined.

D.2 Principle

The minimum sample size shall be large enough in order to have enough particles from the lot being sampled in order to obtain a representative sample for the total lot.

D.3 Determination of factors necessary for the minimum sample size

D.3.1 General

The following factors shall be determined in order to determine the minimum sample size:

- the nominal top size of a particle, d_{95};
- the shape factor f;
- the particle density λ_p
- the distribution factor g;
- the factor p (= the fraction of the particles with a specific characteristic, such as contaminant);
- the coefficient of variation cv.

In the following subclauses it is specified how these factors shall be determined.

D.3.2 Determination of the nominal top size

The nominal top size, d_{95}, shall be determined as specified in EN 15415-1.

D.3.3 Determination of the shape factor

For materials which are more or less granular or have a smaller nominal top size smaller than 50 mm is not useful to determine the shape factor. The shape factor can be taken as 1,0 for all more or less granular materials. For these materials the shape factor will very close to 1,0 and the practical saving in terms of sample size reduction will not outweigh the effort of determining the shape factor. If the shape factor is not determined a value 1,0 shall be used.

To determine the shape factor the following equation shall be used:

$$f = \frac{V_{95}}{d_{95,l}{}^{3}} \tag{D.1}$$

where

f is the shape factor, in mm^3/mm^3;

V_{95} is the maximum volume of a fluff particle (a mass fraction of 95 % of the particles are smaller than V_{95}), in mm^3 (where $V = l \times b \times h$); and

$d_{95,l}$ is the maximum length of a fluff particle (a mass fraction of 95 % of the particles are smaller than d_{95l}), in mm.

The shape factor f is not constant, but depends on the type of fluff-type material. The shape factor generally increases if a material is comminuted.

D.3.4 Determination of the bulk density

The bulk density, λ_b, shall be determined as specified in CEN/TS 15401.

D.3.5 The distribution factor *g*

The distribution factor g, which corrects for the distribution in the particle size depends on the ratio between the nominal top size, d_{95}, and the minimum particle size, d_{05}. Which value for g shall be used shall be deducted from Table D.1.

Table D.1— Distribution factor

Ratio d_{95}/d_{05} [a]	***g***
$d_{95}/d_{05} > 4$	0,25
$2 \leq d_{95}/\mathrm{d}_{05} \leq 4$	0,50
$1 \leq d_{95}/d_{05} < 2$	0,75
$d_{95}/d_{05} = 1$	1,00

[a] d_{05} is the minimum particle size (a mass fraction of 5 % of the particles are smaller than d_{05}).

In the case of fluff-type solid recovered fuels, there is generally a large distribution in the particle size. In many cases this distribution results in a g of 0,25. Almost all granular materials, on the other hand, have a similar particle size. Consequently, g for pellets is generally 1,00.

D.3.6 The factor *p*

The factor p refers to the fraction of the particles with a specific characteristic (such as contaminant). If no value is known or determined for the material, a fixed value of 0,10 shall be maintained for this factor.

D.3.7 The coefficient of variation *cv*

The coefficient of variation *cv* (see 3.1) of 0,1 shall be accepted when taking the aforementioned assumptions to determine a correct minimum sample size.

D.4 Calculation of the minimum sample size

The parameters mentioned in D.3 shall be used in Equation (D.2) to calculate the minimum sample size.

$$m_m = \frac{\pi}{6 \times 10^9} \times d_{95}{}^3 \times f \times \lambda \times g \times \frac{(1-p)}{(cv)^2 \times p} \qquad \text{(D.2)}$$

where

m_m is the mass of the minimum sample size, in kilograms as received;

d_{95} is the nominal top size of a particle (a mass fraction of 95 % of the particles are smaller than d_{95}), in mm;

NOTE If the recovered fuels are of the fluff type, the value for d95l can be used here. For granular materials, both the d95 of the particles in the pellets and the d95 of the pellets themselves can be used.

f is the shape factor, in mm^3/mm^3;

λ is the average particle density of the particles in the solid recovered fuel, in kg/m^3 as received;

g is the correction factor for distribution in the particle size;

p is the fraction of the particles with a specific characteristic (such as a specific contaminant), in kg/kg, and is equal to 0,1;

cv is the coefficient of variation, here set to 0,1.

Examples of the way in which the minimum sample size can be calculated for both fluff-type and granular solid recovered fuels are given below in Tables D.2 and D.3:

EXAMPLE 1

The following specifications have been determined for a fluff-type solid recovered fuel:

- the density (particle density) amounts to 1 000 kg/m^3;
- the bulk density amounts to 80 kg/m^3;
- V_{95} amounts to 95 000 mm^3;
- d_{95} amounts to 190 mm, and d_{05} amounts to 50 mm;
- the shape factor f then amounts to 95 000/190^3 = 1/72,2;
- the ratio d_{95l}/d_{05l} amounts to approximately 3,8; accordingly a value of 0,50 applies to g;

a value of 0,1 is maintained for the factor p and the coefficient of variation cv.

Based on the above values, this leads to a minimum sample size with a weight of $\pi/(6 \times 10^9) \times (190)^3 \times 1/72{,}2 \times 1\,000 \times 0{,}50 \times (1\text{-}0{,}1)/(0{,}1^2 \times 0{,}1)$ = 22,384 kg, and a volume of 22,4/80 × 1 000 = 280 l for the fluff-type solid recovered fuel concerned.

EXAMPLE 2

A granular solid recovered fuel consisting of pellets has a particle density of 1 000 kg/m^3 and a bulk density of 300 kg/m^3. Approximately a mass fraction of 95 % of the pellets has a diameter of 20 mm; however, the d_{95} of the particles in the pellets amounts to 10 mm. A value of 0,1 can be used for the coefficient of variation cv and the factor p. The distribution in the grain size is small, so a value of 1,0 can be assumed for g. As pellets are more or less granular, a value of 1,0 can be used for the shape factor. This leads to a minimum sample size with a weight of $1{,}0 \times \pi/(6 \times 10^9) \times 10^3 \times 1{,}0 \times 1\,000 \times (1\text{-}0{,}1)/(0{,}1^2 \times 0{,}1)$ = 0,471 kg and a volume of 0,471/300 = 0,001 571 m^3 = 1,57 l.

D.5 Quick determination of minimum sample size

D.5.1 Quick determination of minimum sample size for fluff-type solid recovered fuels

Table D.2 shows the minimum sample size for fluff-type solid recovered fuels with a large distribution in the particle size for a series of standard measures. 1 000 kg/m^3 has been assumed for the density (particle density). A value of 0,05 has been used for the shape factor; the distribution factor of the particle size g has been set at 0,25. A value of 0,1 has been assumed for the factor p, as for the coefficient of variation cv.

Table D.2 — General table for the determination of the minimum sample size of fluff-type solid recovered fuels [a]

d_{95l} (mm)	**Minimum sample size** (kg)	**Minimum sample size** (l)					
		Bulk density kg/m^3					
		50	60	75	80	90	100
50	0,8	15	13	10	10	9	8
75	2,5	50	42	34	32	28	25
100	5,9	120	100	80	74	66	59
150	20	400	340	270	250	230	200
200	48	950	790	630	590	530	480
250	92	1 000	1 600	1 300	1 200	1 100	920
300	159	3 000	2 700	2 200	1 500	1 800	1 600

[a] Table D.2 can be used when determining the minimum sample size for fluff-type solid recovered fuels with a density (particle density) of 1 000 kg/m^3, a shape factor f of 0,05, a distribution factor g of 0,25, a factor p of 0,1 and a coefficient of variation cv of 0,1. If the properties of the material deviate markedly from the values used in this table, the minimum sample size shall be calculated.

D.5.2 Quick determination of minimum sample size for granular solid recovered fuels

Table D.3 shows the minimum sample size for granular solid recovered fuels (e.g. pellets) with a small distribution in the grain size for a series of standard measures.

1 000 kg/m^3 has been assumed for the density (particle density). A value of 1,0 has been used for both the shape factor f and the distribution factor of the grain size g. A value of 0,1 has been assumed for the factor p, as for the coefficient of variation cv.

Table D.3 — General table for the determination of the minimum sample size of granular solid recovered fuels [a]

d_{95} [b] (mm)	**Minimum sample size** (kg)	**Minimum sample size** (l)								
		Bulk density (kg/m^3)								
		100	200	250	300	400	500	600	700	800
10	0,5	5	3	2	2	2	1	1	1	1
20	4	38	19	16	13	10	8	7	6	5
30	13	130	64	51	42	32	25	21	18	16
40	30	310	160	130	110	75	60	50	43	38
50	59	590	300	240	200	150	120	98	84	74

[a] Table D.3 can be used when determining the minimum sample size for granular solid recovered fuels with a density (particle density) of 1 000 kg/m^3, a shape factor f and a distribution factor g of 1,0, a factor p and a coefficient of variation cv of 0,1. If the properties of the material deviate markedly from the values used in this table, the minimum sample size shall be calculated.

[b] This may affect both the d_{95} of the particles in the pellets and the d_{95} of the pellets themselves.

Annex E
(normative)

Determination of minimum increment size for sampling from material flows

E.1 Introduction

This annex specifies how the minimum increment size shall be determined for sampling from material flows. Distinction shall be made for the following situations:

- mechanical sampling from a drop flow;
- manual sampling from a drop flow;
- sampling from a conveyor.

E.2 Principle

The size of an increment shall be large enough so that all particles have a chance to be part of the increment. Besides this for increments of material flows and conveyors the particles over the whole breadth of the material flow or conveyor shall have an equal chance of ending up in the increment.

E.3 Determination of minimum increment size for mechanical sampling from a drop flow

For mechanical sampling from a drop flow the dimensions of the sampling equipment shall meet the following requirement:

- The breadth of the increment shall be equal to at least three times the d_{95} of the material for sampling, unless the nominal top size d_{95} is smaller than 3 mm.

The mass of the increment size is calculated using the following equation:

$$m_\mathrm{i} = \phi_d \frac{b}{v_\mathrm{c}} \tag{E.1}$$

where

m_i is the mass of the increment size, in kg;

Φ_d is the drop flow, in kg/s;

b is the breadth of the increment, in m;

v_c is the velocity at which the collection tray moves through the drop flow, in m/s ($\leq$ 0,6 m/s).

Providing that the breadth of the increment is equal to the minimum increment breadth (three times d_{95}), and the velocity of the material collection is equal to the maximum velocity (0,6 m/s), the mass of the minimum increment size for material with d_{95} greater than 3 mm can be calculated as follows:

$$m_\mathrm{m} = 5\phi_d \frac{d95}{1\,000} \tag{E.2}$$

where

m_m is the mass of the minimum increment size, in kg;

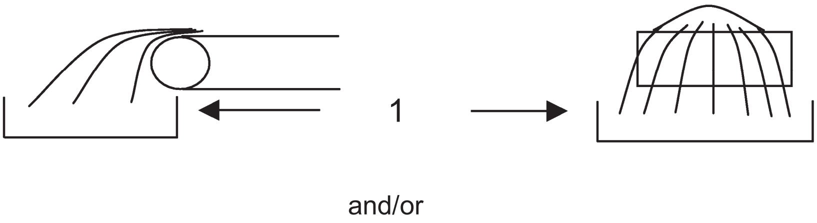
Φ_d is the drop flow, in kg/s;

d_{95} is the nominal top size, in mm.

NOTE The above equation can only be used for a (virtually) constant conveyor load. Major discontinuities in the mass flow or conveyor load can therefore be avoided as far as possible.

E.4 Determination of minimum increment size for manual sampling from a drop flow

The breadth of the increment and the collection tray shall be at least equal to the breadth of the drop flow (see also Figure E.1).



Key

1 collection tray

Figure E.1 — Schematic representation of the full breadth of the drop flow

If it is assumed that the time when only part of the drop flow ends up in the collection tray (while the tray is moving in and out of the drop flow) is negligible when compared with the time when the material flow falls entirely into the collection tray, the mass of the increment size is equal to

$$\mathrm{m_i} = \phi_\mathrm{d} \times \mathrm{t_m} \tag{E.3}$$

where

m_i is the mass of the increment size, in kg;

Φ_d is the drop flow, in kg/s;

t_m is the sampling time, in s.

The sampling time shall be chosen in such a way that the required number of increments results in sufficient material in order to meet the minimum sample size.

Assuming that the collection tray is moved through the drop flow at a constant velocity, the mass of the increment size is equal to

$$m_{\mathrm{i}} = \varphi_{\mathrm{d}} \frac{b_{\mathrm{s}}}{v_{\mathrm{c}}} \qquad \text{(E.4)}$$

where

m_{i} is the mass of the increment size, in kg;

Φ_{d} is the drop flow, in kg/s;

b_{s} is the breadth of the drop flow in the direction in which the collection tray is moved, in metres;

v_{c} is the velocity at which the collection tray moves through the drop flow, in m/s (≤ 0,6 m/s).

The above equation shall only be used for a (virtually) constant conveyor load. Major discontinuities in the mass flow or conveyor load shall therefore be avoided as far as possible.

E.5 Determination of minimum increment size for sampling from a conveyor

For determining the minimum increment size when sampling from a conveyor no distinction is made between manual sampling from a stationary conveyor and mechanical sampling from a moving conveyor. As regards the determination of the dimensions of the sampling equipment, these shall be determined using the following requirements:

- the breadth of the increment shall be equal to at least three times the d_{95} of the material for sampling, if this has a d_{95} greater than 3 mm;
- for materials that have a d_{95} smaller than 3 mm, the breadth of the increment shall be equal to 10 mm;
- the length of the increment shall be as large as the breadth of the material flow on the conveyor (and no more than equal to the breadth of the conveyor);
- the height of the increment shall be equal to the height of the conveyor load at the point where the increment is taken.

If the d_{95} is greater than 3 mm and the breadth of the increment is chosen to be equal to three times the d_{95}, the minimum increment size shall be determined by the following equation:

$$m_{\mathrm{m}} = b \times G = \frac{3 \times d_{95} \times \mathrm{G}}{1000} \qquad \text{(E.5)}$$

where

m_{m} is the mass of the minimum increment size, in kg;

b is the breadth of the increment, in m;

G is the conveyor load, in kg/m;

d_{95} is the nominal top size (d_{95}), in mm.

If the d_{95} is smaller than 3 mm, the minimum increment size shall be determined by the following equation:

$$m_{\mathrm{m}} = b \times G = 0{,}01 \times G \tag{E.6}$$

where

m_{m} is the mass of the minimum increment size, in kg;

b is the breadth of the increment, in metres (= 0,01 m);

G is the conveyor load, in kg/m.

NOTE The above equation can only be used for a (virtually) constant conveyor load. Major discontinuities in the mass flow or conveyor load should therefore be avoided as far as possible.

Annex F
(normative)

Determination of minimum increment size for sampling from static lots or vehicles

F.1 Introduction

This annex specifies how the minimum increment size shall be determined for sampling from static lots or vehicles.

F.2 Principle

The size of an increment shall be large enough so that all particles have a chance to be part of the increment.

F.3 Procedure

The minimum increment size shall be in terms of volume at least three times the nominal top size in all dimensions of the particles with the nominal top size. To determine the mass of the minimum increment size for solid recovered fuels with a d_{95} greater than 3 mm, Equation (F.1) shall be used:

$$m_\mathrm{m} = 2{,}7 \times 10^{-8} \times {d_{95}}^3 \times \lambda_\mathrm{s} \tag{F.1}$$

where

m_m is the mass of the minimum increment size, in kg;

d_{95} is the nominal top size (a mass fraction of 95 % of the particles are smaller than d_{95}), in mm;

λ_b is the bulk density of the flow, in kg/m^3.

If the d_{95} of a material is smaller than 3 mm, Equation (F.2) shall be used:

$$m_\mathrm{m} = 1 \times 10^{-6} \times \lambda_\mathrm{b} \tag{F.2}$$

where

m_m is the mass of the minimum increment size, in kg;

λ_b is the bulk density of the flow, in kg/m^3.

Annex G
(normative)

Implementation of sampling plan from a material flow

G.1 Introduction

This annex specifies how the implementation of sampling from a material flow shall be performed. Three different situations exist how sampling can be performed from a material flow. These situations are described in separate procedures which describe how the sampling shall be performed for the specific situation. The different situations are the following:

a) mechanical or manual sampling from the drop flow;

b) mechanical sampling from a moving conveyor;

c) manual sampling from a stationary conveyor.

G.2 Principle

The implementation of sampling from a material flow shall be performed in such a way that the basic principles (see Clause 5) for sampling shall not be neglected.

G.3 Procedure verification of sampling aspects

The aspects below shall be checked and verified before the actual sampling process can begin:

a) use a sampling record to record the data;

b) verify all data on the sampling plan, and note on the sampling record only those data that deviate from the sampling plan. Also report the reasons for the deviations detected;

c) if necessary, determine the d_{95} and the conveyor load;

d) if applicable, and where possible: check the velocity of the conveyor and the load for the conveyor;

e) record the data on the sampling record;

f) verify whether the safety situation for the sampler has actually been secured adequately;

g) verify whether the sampling equipment is clean and in good working order.

G.4 Procedure: Mechanical or manual sampling from the drop flow

A collection tray shall be used for both mechanical and manual sampling from the drop flow. The following steps shall be completed to implement either mechanical or manual sampling from the drop flow.

a) The collection tray shall satisfy the following requirements:

- the direction of movement shall be perpendicular to the direction of movement during the sampling;
- the size of the collection tray shall be large enough to enable all the material in the drop flow to end up in the collection tray (see Figure G.1);
- the size of the collection tray shall be such that no more than 75 % of its capacity is taken up by one increment;
- the particles that fall on the edge of the collection tray moving through the material flow shall have an equal chance of ending up or not ending up in the tray;
- the material of the collection tray shall not have any impact on the material sampled.

b) It is important that the collection tray shall be moved through the entire flow at a constant velocity when taking the sample of a drop flow. All locations from the cross-section of the drop flow shall be sampled, using the collection tray, during the same time period. In practice, the most convenient way of doing this is for the collection tray to be moved through the drop flow at a right angle to the direction of the transport system. Figure G.2 is a schematic drawing of the taking of an increment.

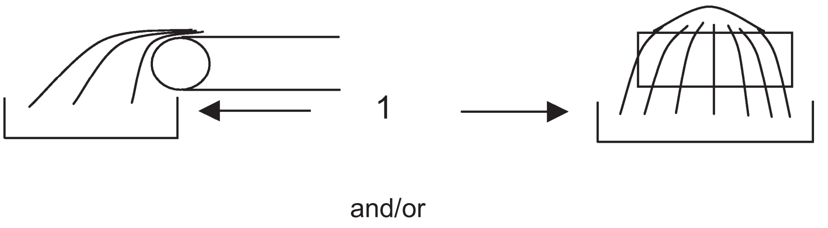
c) Choose a constant velocity that enables a sufficiently large increment to be taken.

d) Take the increments at the times determined in the sampling plan. The times shall preferably be drawn in a stratified random way.

e) Check whether the increment size of each increment is equal to the effective increment size by weighing or by volume (see Table D.2).

f) Put the increments (at least 24 for a lot weighing 1,5 × 10^6 kg) together to form one sample. Check whether the minimum or effective sample sizes are satisfied by weighing or by volume (see Table D.2).

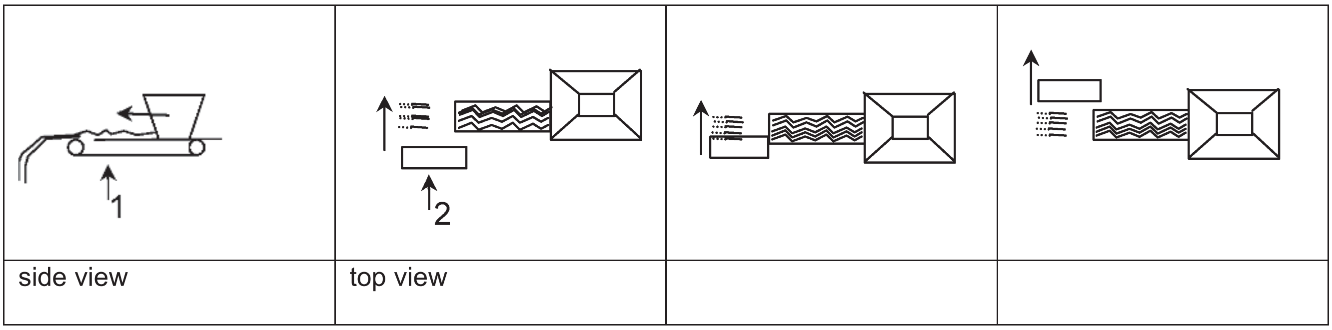
g) Describe all actions taken and all relevant deviations from the sampling plan on the sampling record.



Key

1 collection tray

Figure G.1 — Schematic representation of the full breadth of the drop flow



Key

1 transport system

2 collection tray

Figure G.2 — Schematic representation of sampling from drop flow

G.5 Procedure: Mechanical sampling from a moving conveyor

For mechanical sampling from a moving conveyor, the following steps shall be completed.

a) Check whether the mechanical sampling equipment satisfies the following requirements:

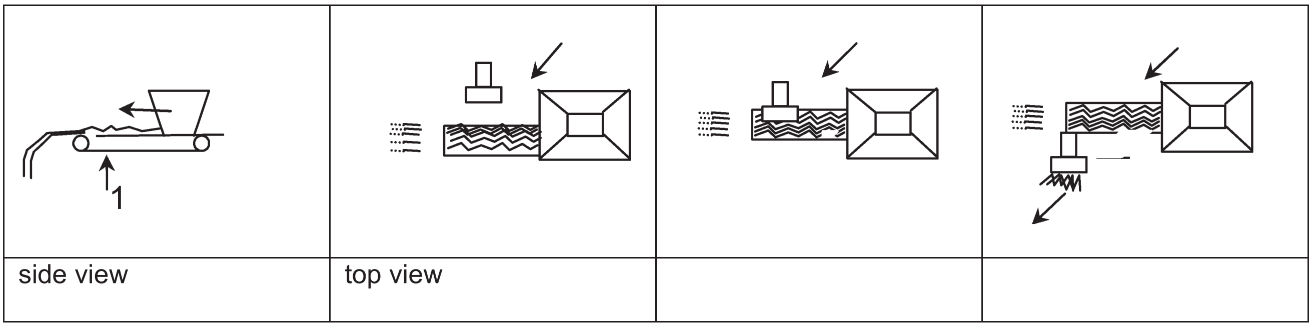
   - the dimensions shall be large enough for the required increment;
   - the equipment shall be sufficiently robust;
   - use of sampling equipment shall not lead to chemical or physical changes in the (sampled) material.
   - the sampling equipment shall sample all material that is directly in front of the sampler at the sampling time. As the transport velocity via the conveyor increases and the velocity of the sampling equipment decreases, the equipment will have to be placed at more of an angle to the conveyor (see Figure G.3);
   - the cutting action shall be executed at a constant velocity;
   - the sampling equipment shall sample all material;
   - the particles on the edge of the cutting face shall have an equal chance of being included or not being included in the sample;
   - the material shall be sampled across the full breadth of the conveyor using the sampling equipment.

b) Set up the equipment in such a way that the increments can be taken directly, preferably at the times drawn in a stratified random way. If just manual operation is present, the mechanical sampling shall be put into action at the times drawn.

c) Check whether the increment size of each increment is equal to the effective increment size by weighing or by volume (see Table D.2).

d) Put the increments (at least 24 for a lot weighing $1,5 \times 10^6$ kg) together to form one sample. Check whether the minimum or effective sample sizes are satisfied by weighing or by volume (see Table D.2).

e) Describe all actions taken and all relevant deviations from the sampling plan on the sampling record.



Key

1 transport system

Figure G.3 — Schematic representation of sampling from the conveyor

G.6 Procedure: Manual sampling from a stationary conveyor

For manual sampling from a stationary conveyor, the following steps shall be completed.

a) Check whether the following requirements are satisfied:

- check whether the use of a sampling frame (see also Annex C) is possible. This is a requisite for manual sampling from a conveyor;
- the dimensions of the sampling frame shall be large enough for the required increment, and shall cover the full breadth of the conveyor (length of sampling frame). The plates shall follow the form/cavity of the conveyor, for example straight for a flat conveyor, arched for a concave conveyor arch and angular for a V-shaped conveyor;
- the sampling frame shall be sufficiently robust;
- use of the sampling frame shall not lead to chemical or physical changes in the (sampled) material;
- the cutting action shall be perpendicular to the direction of transport through the positioning of the sampling frame;
- the particles on the edge of the cutting face of the sampling frame shall have an equal chance of being included or not being included in the sample;
- all material between the two plates in the location of the increment shall be included. (This requirement can only be imposed for the sampling of granular solid recovered fuels. For fluff-type material, C.6 applies.)

b) Stop the conveyor, preferably at the times drawn in a stratified random way.

c) At these times, place the sampling frame with a sawing movement perpendicular to the direction of movement of the conveyor, and take the increments.

d) Check whether the increment size of each increment is equal to the effective increment size by weighing or by volume (see Table D.2).

e) Put the increments (at least 24 for a lot weighing 1,5 × 10^6 kg) together to form one sample. Check whether the minimum or effective sample sizes are satisfied by weighing or by volume (see Table D.2).

f) Describe all actions taken and all relevant deviations from the sampling plan on the sampling record.

Annex H
(normative)

Implementation of the sampling plan from a static lot or vehicle

H.1 Introduction

This annex specifies how the implementation of sampling plan from a static lot or vehicle shall be performed by the sampler. Two different situations exist how sampling can be performed from a static lot or a vehicle. These situations are described in separate procedures which describe how the sampling shall be performed for the specific situation. The different situations are the following:

a) implementation of sampling in locations chosen in a stratified random way;

b) implementation of sampling in locations chosen in a stratified way after rearranging or moving part of the lot.

H.2 Principle

The implementation of sampling from a material shall be performed in such a way that the basic principles (see Clause 5) for sampling shall not be neglected.

H.3 Procedure

The aspects below shall be checked and verified before the actual sampling process can begin:

a) check whether the lot is easily accessible and whether the increments can be taken manually. If the increments can be taken manually, take samples manually following the procedure in H.4;

b) use a sampling record to record the data;

c) verify all data on the sampling plan, and note on the sampling record only those data that deviate from the sampling plan. Also report the reasons for the deviations detected;

d) if necessary, determine the d_{95} (and, in the case of fluff-type materials, the shape factor f);

e) if applicable, measure the position of the lot with respect to fixed identification points such as buildings, enclosures and so on;

f) determine the dimensions of the lot or store;

g) record all data on the sampling record;

h) verify whether the safety situation for the sampler has actually been secured adequately;

i) verify whether the sampling equipment is clean and in good working order.

H.4 Implementation of sampling in locations chosen in a stratified random way

a) Divide the lot or store into as many strata of equal dimensions as the number of increments to be taken;

b) inside each stratum, take an increment the size of the effective increment size in a (preferably) random way;

c) check whether the increment size of each increment is equal to the effective increment size by weighing or by volume (see Table D.2);

d) put the increments (at least 24 for a lot weighing $1,5 \times 10^6$ kg) together to form one sample. Check whether the minimum or effective sample sizes are satisfied by weighing or by volume (see Table D.2) or by volume (see Table D.2);

e) record details of the implementation of the sampling, and the approach followed, on the sampling record.

Annex I
(normative)

Minimum sample size required for analysis

I.1 Introduction

This annex specifies how the minimum sample size required by the laboratory shall be calculated.

I.2 Principle

The minimum sample size required by the laboratory shall be calculated in such a way that each portion will remain representative for the lot of which the sample was taken.

I.3 Procedure

The minimum sample size required for analyses shall be calculated by summing all required test portion sizes as mentioned in Table I.1.

Table I.2 shows the minimum required test masses and their requirements for all analyses methods standardised for solid recovered fuels.

Table I.1 — Test portion sizes and their requirements

Number	Title	Particle size	Test portion size for a single determination	Test portion size for a duplicate determination
EN 15440	Solid recovered fuels – Methods for the determination of biomass content	< 1 mm	11 g	22 g
EN 15400	Solid recovered fuels – Methods for the determination of calorific value	< 1 mm	1,1 g + 1,1 g determination of moisture in the analysis sample (also including ash for biomass content)	2,2 g + 2,2 g determination of moisture in the analysis sample (also including ash for biomass content)
CEN/TS 15401	Solid recovered fuels – Determination of bulk density	As received	70 l (including 30 % compacting) Pellets 7 l (including 30 % compacting)	70 l (including 30 % compacting) Pellets 7 l (including 30 % compacting)
CEN/TS 15414-1	Solid recovered fuels – Determination of moisture content using	Up to 100 mm	2 000 g	

Number	Title	Particle size	Test portion size for a single determination	Test portion size for a duplicate determination
CEN/TS 15414-2 EN 15414-3	the oven dry method – Part 1: Determination of total moisture by a reference method Part 2: Determination of total moisture by a simplified method Part 3: Moisture in general analysis sample	< 30 mm < 1 mm	500 g 1,2 g	2,2 g
EN 15402	Solid recovered fuels – Determination of the content of volatile matter	< 1 mm	1,1 g + 1,1 g for determination of moisture in the analysis sample	2,2 g + 2,2 g for determination of moisture in the analysis sample
EN 15403	Solid recovered fuels – Determination of ash content	< 1 mm	1,1 g + 1,1 g for determination of moisture in the analysis sample	2,2 g + 2,2 g for determination of moisture in the analysis sample
CEN/TR 15404	Solid recovered fuels – Methods for the determination of ash melting behaviour by using characteristic temperatures	< 1 mm	100 g (wood materials) 25 g (SRF)	200 g (wood materials) 50 g (SRF)
EN 15415-1	Solid recovered fuels – Determination of particle size distribution – Part 1: Screen method for small dimension particles	As received	2,5 kg (including 500 g for moisture content) 100 % < 25 mm; 1,5 kg (including 500 g for moisture content)	4,5 kg (including 500 g for moisture content) 100 % < 25 mm; 2,5 kg (including 500 g for moisture content)
CEN/TS 15405	Solid recovered fuels – Methods for the determination of the density of pellets and briquettes	As received	500 g pellets Or 15 briquettes	500 g pellets Or 15 briquettes
CEN/TS 15639	Solid recovered fuels – Determination of mechanical durability of pellets	As received	2,5 kg	2,5 kg
CEN/TS 15406	Solid recovered fuels – Determination of	As received	1,1 m^3	1,1 m^3

Number	**Title**	**Particle size**	**Test portion size for a single determination**	**Test portion size for a duplicate determination**
	bridging properties of bulk material		For coalescing materials 1 kg	For coalescing materials 1 kg
EN 15407	Solid recovered fuels – Methods for the determination of carbon (C), hydrogen (H) and nitrogen (N) content		100 g	200 g
EN 15408	Solid recovered fuels – Method for the determination of sulphur (S), chlorine (Cl), fluorine (F) and bromine (Br) content		100 g	200 g
EN 15410	Solid recovered fuels – Method for the determination of the content of major elements (Al, Ca, Fe, K, Mg, Na, P, Si, Ti)		400 g	800 g
EN 15411	Solid recovered fuels – Methods for the determination of the content of trace elements (As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Mn, Ni, Pb, Sb, Se, Tl, V and Zn)		600 g	1,2 kg
CEN/TS 15412	Solid recovered fuels – Methods for the determination of metallic aluminium		200 g	400 g
EN 15413	Solid recovered fuels – Methods for the preparation of the test sample from the laboratory sample	<1 cm	< 10 kg	< 20 kg

Table I.2 — Requirements for different parameters

Parameter (single or group)	Minimum laboratory sample amount (g) [a]	Short term storage conditions before delivery to the laboratory	Long term storage condition before delivery to the laboratory	Container material
C, H, N	100	In the same condition of SRF production refrigeration	4 °C	plastic bottle or bag
Cl, S, Br, F	100	In the same condition of SRF production refrigeration	4 °C	non-PVC plastic bottle or bag
Metallic Al	200	In the same condition of SRF production refrigeration	4 °C	plastic bottle or bag
Major cations	400	In the same condition of SRF production refrigeration	4 °C	plastic bottle or bag
Minor elements excluding Hg	200	In the same condition of SRF production refrigeration	4 °C	plastic bottle or bag
Hg	100	In the same condition of SRF production refrigeration	4 °C	glass or PFA bottle
C, H, N, Cl, S, Br, F	150	In the same condition of SRF production refrigeration	4 °C	non-PVC plastic bottle or bag
Major cations + minor elements excluding Hg	500	In the same condition of SRF production refrigeration	4 °C	plastic bottle or bag
Major cations + Minor elements + Hg	600	In the same condition of SRF production refrigeration	4 °C	Glass bottle (100 g) + plastic bottle or bag
Major cations + Minor elements + Hg + metallic Al	700	In the same condition of SRF production	4 °C	Glass bottle (100 g) + plastic bottle or bag

Parameter (single or group)	**Minimum laboratory sample amount (g)** [a]	**Short term storage conditions before delivery to the laboratory**	**Long term storage condition before delivery to the laboratory**	**Container material**
		refrigeration		
Complete analysis	800	In the same condition of SRF production refrigeration	4 °C	Glass bottle (100 g) + non-PVC plastic bottle or bag

[a] The maximum grain size (mm) is related to the laboratory sample amount (g) in order to guarantee sample homogeneity. It is established following the rules reported in EN 15443.

Annex J
(normative)

Standard sampling plans for common situations

J.1 Introduction

This annex specifies three sampling plans for common situations where a sampling needs to be performed for solid recovered fuels. These three sampling plans intend to cover most common situations where sampling of a solid recovered fuel is required.

The sampling plan for sampling of granular material sampled from a moving conveyor uses another but correct method for determining the increment size than described in Annex E. It is based on the method for the determination of the minimum increment size for sampling from static heaps.

J.2 Sampling of granular SRF <25 mm from a moving conveyor

1) General information

Project (number)	*Fill in*	
Name of project leader Telephone	*Fill in*	
Name of sampler and company Telephone	*Fill in*	
Sampling date	*Fill in*	
Sampling location Street Town/city	*Fill in*	
Contact on site Telephone	*Fill in*	
Name of solid recovered fuel	*Fill in*	
Description of material for sampling	*Fill in*	
Sampling objective	*Fill in*	The objective is the reason why a sample is taken.

2) Definition of lot and lot size

Material flow	*Fill in*	tons/hour	Determine or estimate the material flow in tons per hour
Sampling period	*Fill in*	hours	
Lot size dimension	*Calculate and fill in*	tons	Multiply the two values above. This value shall be less than 1,5 × 10^6 kg. Otherwise the lot shall be spitted in to more lots until the lot size is less than. 1,5 × 10^6 kg.

3) Information on sampling location and possible sampling procedure

	☐ mechanical sampling from the conveyor belt ☐ manual sampling from the conveyor belt		Choose the highest ranking method
Breadth of the sampling equipment which crosses the material flow	75	mm	

4) Information on solid recovered fuel

Nominal top size	< 25	mm	
Dominant shape of particles with nominal top size	granular		
Bulk density	> 300	kg/m^3	
Particle density	≈ 1,0	g/cm^3	

5) Information on increment and sample sizes

Minimum increment size. Measure the increment size by taking an increment with sampling equipment measuring 75 mm width and weigh the weight.	Litres	The minimum increment size shall be larger than 1,0 litre. If it is smaller more increments or larger increments need to be taken.
Minimum sample size	24 Litres	

6) Increments to be taken and the times

The sampling equipment (e.g. a sampling frame) used in order to take the increment from the conveyor shall be at least 7,5 cm wide and shall cross the entire material flow perpendicular in a sectional plane. Each increment is 1/24 of the sampling period later than the preceding increment.

Increment number 1	0 h and 0 min	Increment number 13	..… h and ..… min
Increment number 2	- ….. h and ..… min	Increment number 14	….. h and ..… min
Increment number 3	- ….. h and ..… min	Increment number 15	….. h and ..… min
Increment number 4	- ….. h and ..… min	Increment number 16	….. h and ..… min
Increment number 5	- ….. h and ..… min	Increment number 17	….. h and ..… min
Increment number 6	- ….. h and ..… min	Increment number 18	….. h and ..… min
Increment number 7	- ….. h and ..… min	Increment number 19	….. h and ..… min
Increment number 8	- ….. h and ..… min	Increment number 20	….. h and ..… min
Increment number 9	- ….. h and ..… min	Increment number 21	….. h and ..… min
Increment number 10	- ….. h and ..… min	Increment number 22	….. h and ..… min
Increment number 11	- ….. h and ..… min	Increment number 23	….. h and ..… min
Increment number 12	- ….. h and ..… min	Increment number 24	….. h and ..… min

7) Storage

The samples shall be kept in a dry room, in tightly sealed packaging. If the size of the (sub-) samples is too large, they may be kept in a dry room.

[a] The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material.

8) Deviations detected

All deviations regarding this Standard introduced in the sampling plan shall be reported and sufficiently justified. All deviations regarding the sampling plan encountered in the field operation shall be reported and sufficiently justified. **If sufficiently motivated mentioning deviations is a sign of quality.**

9) Approval of sampling plan and sampling record

	Name	Signature	Date
Project leader			
Sampler			

Appendices

1. Calculating increment and sample sizes
2. Photos of the location/position of random check lots/sampling
3. ………………………………………

J.3 Sampling of granular SRF <25 mm from a static lot

General information

Project (number)	*Fill in*	
Name of project leader Telephone	*Fill in*	
Name of sampler and company Telephone	*Fill in*	

Sampling date	*Fill in*	
Sampling location Street Town/city	*Fill in*	
Contact on site Telephone	*Fill in*	
Name of solid recovered fuel	*Fill in*	
Description of material for sampling	*Fill in*	
Sampling objective	*Fill in*	The objective is the reason why a sample is taken.

2) Definition of lot and lot size

Dimensions of the static lot	*Fill in*		Determine the average height, depth and length of the static lot
- height		m	
- depth		m	
- length		m	
Calculate the volume of the lot	*Fill in*	m^3	Multiply the three distances above
Bulk density	*Fill in*	tons/m^3	
Lot size dimension	*Calculate and fill in*	tons	Multiply the volume of the lot with the bulk density

3) Information on sampling location and possible sampling procedure

	☐ stratified random sampling; ☐ stratified sampling.	Choose the highest ranking method

4) Information on solid recovered fuel

Nominal top size	< 25	mm	
Dominant shape of particles with nominal top size	granular		
Bulk density	> 300	kg/m^3	
Particle density	≈ 1,0	g/cm^3	

5) Information on increment and sample sizes

Minimum increment size	1,0	Litres	
Minimum sample size	24	Litres	

6) Increments and the locations where to take them

The sampling equipment (e.g. a scoop) used in order to take the increment from the vehicle shall be at least 7,5 cm wide and straight edges which are just as high as the width of the scoop. A grid of 4 by 6 strata shall be laid over lot. In each stratum an increment shall be taken alternating in top, middle and lower section of the depth of the stratum.

7) Storage

The samples shall be kept in a dry room, in tightly sealed packaging. If the size of the (sub-) samples is too large, they may be kept in a dry room. [a] The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material.

8) Deviations detected

All deviations regarding this Standard introduced in the sampling plan shall be reported and sufficiently justified. All deviations regarding the sampling plan encountered in the field operation shall be reported and sufficiently justified. **If sufficiently motivated mentioning deviations is a sign of quality.**

9) Approval of sampling plan and sampling record

	Name	Signature	Date
Project leader			
Sampler			

Appendices

1. Calculating increment and sample sizes
2. Photos of the location/position of random check lots/sampling
3. ………………………………………

J.4 Sampling of granular SRF <25 mm from a vehicle

General information

Project (number)	*Fill in*	
Name of project leader Telephone	*Fill in*	
Name of sampler and company Telephone	*Fill in*	
Sampling date	*Fill in*	
Sampling location Street Town/city	*Fill in*	
Contact on site Telephone	*Fill in*	
Name of solid recovered fuel	*Fill in*	
Description of material for sampling	*Fill in*	

Sampling objective	*Fill in*	The objective is the reason why a sample is taken.

2) Definition of lot and lot size

Number of vehicles	*Fill in*		Determine or estimate the number vehicles
Sampling period	*Fill in*	tons	Average weight per vehicle
Lot size dimension	*Calculate and fill in*	tons	Multiply the two values above. This value shall be less than 1,5 × 10^6 kg. Otherwise the lot shall be spitted in to more lots until the lot size is less than. 1,5 × 10^6 kg

3) Information on sampling location and possible sampling procedure

	☐ mechanical sampling with an automatic sampling device ☐ manual sampling	Choose the highest ranking method

4) Information on solid recovered fuel

Nominal top size	< 25	mm	
Dominant shape of particles with nominal top size	granular		
Bulk density	> 300	kg/m^3	
Particle density	≈ 1,0	g/cm^3	

5) Information on increment and sample sizes

Minimum increment size	1,0	Litres	
Minimum sample size	24	Litres	

6) Increments to be taken

The sampling equipment (e.g. a scoop or a gouge) used in order to take the increment from the shall be at least 7,5 cm wide and should cross the whole perpendicular sectional plane. In every vehicle at least one increment shall be taken right in the middle of the vehicle. If the number of vehicles is less than 24, the number of increments for each vehicle shall be the rounded up figure of 24 divided by the number of vehicles.

Increment number	Vehicle number	Location in vehicle	Increment number	Vehicle number	Location in vehicle
1	nr.1		13	nr…	nr.1
2	nr. ..		14	nr. ..	nr. ..
3	nr. ..		15	nr. ..	nr. ..
4	nr. ..		16	nr. ..	nr. ..
5	nr. ..		17	nr. ..	nr. ..
6	nr. ..		18	nr. ..	nr. ..
7	nr. ..		19	nr. ..	nr. ..
8	nr. ..		20	nr. ..	nr. ..
9	nr. ..		21	nr. ..	nr. ..
10	nr. ..		22	nr. ..	nr. ..
11	nr. ..		23	nr. ..	nr. ..
12	nr. ..		24	nr. ..	nr. ..

7) Storage

The samples shall be kept in a dry room, in tightly sealed packaging. If the size of the (sub-) samples is too large, they may be kept in a dry room.

[a] The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material.

8) Deviations detected

All deviations regarding this Standard introduced in the sampling plan shall be reported and sufficiently justified. All deviations regarding the sampling plan encountered in the field operation shall be reported and sufficiently justified. **If sufficiently motivated mentioning deviations is a sign of quality.**

9) Approval of sampling plan and sampling record

	Name	Signature	Date
Project leader			
Sampler			

Appendices

1. Calculating increment and sample sizes
2. Photos of the location/position of random check lots/sampling
3. ……………………………………

Annex K
(informative)

Additional information about precision

K.1 Introduction

The precision can be subdivided into: the trueness, the repeatability, the reproducibility and the robustness of a method. In the European project QUOVADIS research has been performed in order to obtain data on the precision of technical specifications on solid recovered fuels. Deliverable 4.2 [24], and deliverable 4.3 [25], of QUOVADIS deal with sampling. The data on the precision in this clause shows the combined results of the entire process of sampling, sample preparation, digestion and analysis. The sample preparation, digestion and analysis, however, have been performed by the same laboratory with identical procedures.

K.2 Scope

This annex contains informative data on the precision of sampling of solid recovered fuels.

K.3 Trueness

The trueness is the extent to which method gives the correct result. The determination of trueness requires information about the exact composition of the solid recovered fuel before sampling. The composition of waste is by definition unknown. Therefore it is not possible to determine the trueness of a method, unless synthetic waste is produced. It is unfeasible to produce synthetic lots of solid recovered fuels with a common lot size of 300 tons to 1 500 tons.

K.4 Repeatability and reproducibility

In QUOVADIS the repeatability of sampling of solid recovered fuels has been determined on 4 types of solid recovered fuel. Those 4 types of solid recovered fuel were sampled by 5 different samplers each from another EU country. The 4 types of SRF were:

1) soft pellets derived from municipal solid waste;

2) soft pellets derived from commercial solid waste;

3) hard pellets derived from commercial and bulky waste;

4) mining residues and industrial residues.

Table 1 shows data on the repeatability and reproducibility of measurements on solid recovered fuels. These measurements include analysis, digestion sample preparation and sampling. Excluding sampling the repeatabilities and reproducibilities are rather similar and in almost 50 % of the case larger than those including sampling. It can therefore be concluded that the large influence on the variance of the measurement is not the sampling operation. Since sample preparation is nothing else as a repetition of sampling operation it is very likely that the larger source of error in the variance is caused during the entire sample preparation in both the field and laboratory operation of sample preparation.

NOTE In theory the reproducibility shall be larger than the repeatability. The results from QUOVADIS show that this is in roughly 50 % of the cases not the case. This can only be caused by a large imbalance in the results.

Table 1— Repeatability and reproducibility

Parameter	Statistical parameter	Average	Upper limit 90-% confidence interval
Dry matter	Relative repeatability	0,5 %	1,1 %
	Relative reproducibility	0,7 %	1,6 %
Net calorific value	Relative repeatability	2,3 %	4,6 %
	Relative reproducibility	3,1 %	4,8 %
Chlorine	Relative repeatability	21 %	39 %
	Relative reproducibility	23 %	40 %
Antimony	Relative repeatability	40 %	100 %
	Relative reproducibility	42 %	90 %
Arsenic	Relative repeatability	46 %	120 %
	Relative reproducibility	48 %	120 %
Lead	Relative repeatability	64 %	180 %
	Relative reproducibility	64 %	170 %
Cadmium	Relative repeatability	73 %	150 %
	Relative reproducibility	74 %	150 %
Chromium	Relative repeatability	48 %	150 %
	Relative reproducibility	46 %	140 %
Cobalt	Relative repeatability	25 %	51 %
	Relative reproducibility	23 %	45 %
Copper	Relative repeatability	120 %	300 %
	Relative reproducibility	120 %	280 %
Manganese	Relative repeatability	20 %	53 %
	Relative reproducibility	19 %	43 %
Nickel	Relative repeatability	81 %	250 %
	Relative reproducibility	78 %	244 %
Mercury	Relative repeatability	35 %	140 %
	Relative reproducibility	38 %	140 %
Thallium	Relative repeatability	n.b.	n.b.
	Relative reproducibility	n.b.	n.b.
Vanadium	Relative repeatability	17 %	28 %
	Relative reproducibility	21 %	29 %

For parameters with repeatabilities or reproducibilities larger than 25 % it is recommended to take and analyse duplicate samples for a single lot.

K.5 Robustness

The robustness is the extent of the method to what it is subject to influencing parameters. These influencing parameters are numerous e.g. type of solid recovered fuel, increment size, sample size, lot size and number increments.

Type of solid recovered fuel

The type of solid recovered fuel has a tremendous effect on the precision of the measurement. Solid recovered fuels with a very small particle size and a very homogenous bulk composition show good repeatabilities and reproducibilities. Solid recovered fuels with a larger nominal top size and a heterogeneous bulk composition are show poor repeatabilities and reproducibilities for micro parameters such as copper, nickel and mercury. The poor robustness for the type of solid recovered fuel is mostly caused by imperfection of sample preparation method to deal with extremely heterogeneous materials. Table 1 shows large variation for the repeatabilities and reproducibilities for a single parameter. This large variation is mostly caused by the differences between the investigated types of solid recovered fuel.

Increment and sample size

The increment size influences the precision of the measurement. An investigation by Tauw for ISB, [27], shows that a decreased increment size decreases the precision of the measurement for bulk parameters. If measurement techniques of the current state-of-the-art are used a reduced increment size decreases the precision of the measurement for bulk parameters. This decreased precision could not be demonstrated for microparameters due to the variation caused by the imperfections of sample preparation.

Lot size

Theoretically the lot size influences the precision, but the influence of the other parameters in the sampling procedure probably exceeds the influence of the lot size. Therefore, the influence of the lot size has not been clearly identified in the ruggedness testing in QUOVADIS.

Number of increments

Theoretically the number of increments influences the precision, but the influence of the other parameters in the sampling procedure probably exceeds the influence of the number of increments. Therefore, the influence of the number of increments has not been clearly identified in the ruggedness testing in QUOVADIS.

Annex L
(informative)

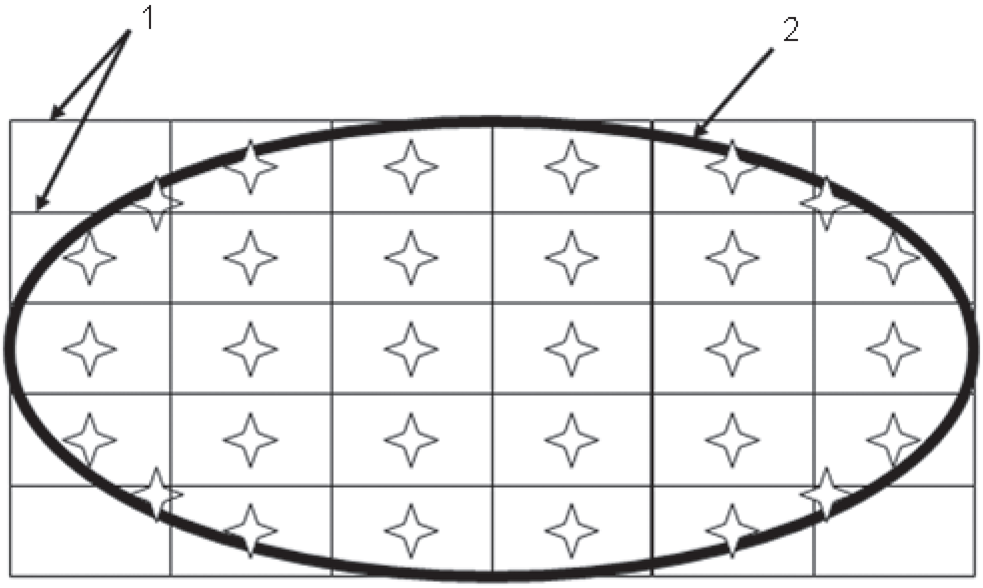
Distribution of increments

L.1 Scope

This annex specifies visual examples for stratified and stratified random sampling.

L.2 Stratified sampling

Figure L.1 shows how the increments can be located over static lot if stratified sampling is applied. The stars show where an increment can be taken.



Key

1 boundaries strata

2 ground surface static lot

Figure L.1 — Stratified sampling in a static lot

Figure L.2 shows how the increments can be located over the lot which is specified as a certain production period if stratified sampling is applied. The arrows show where an increment can be taken. T_0 is the starting time and t_{end} is the end time of the production period.

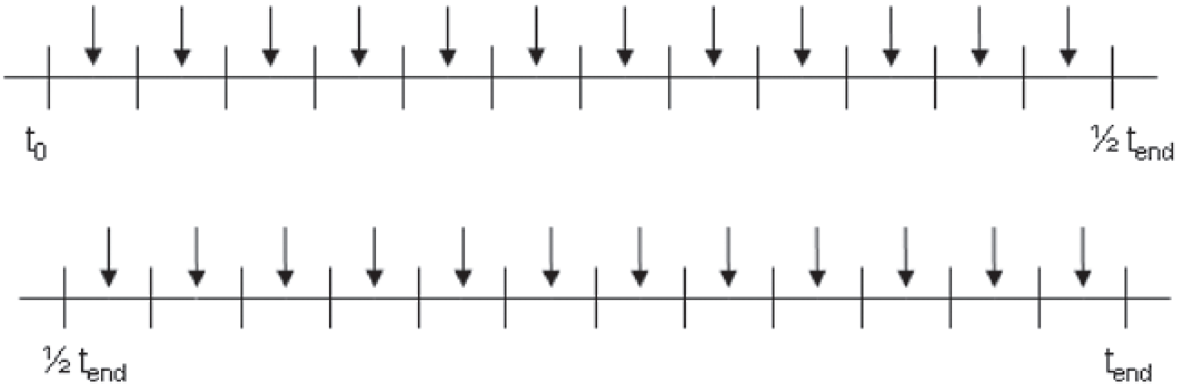
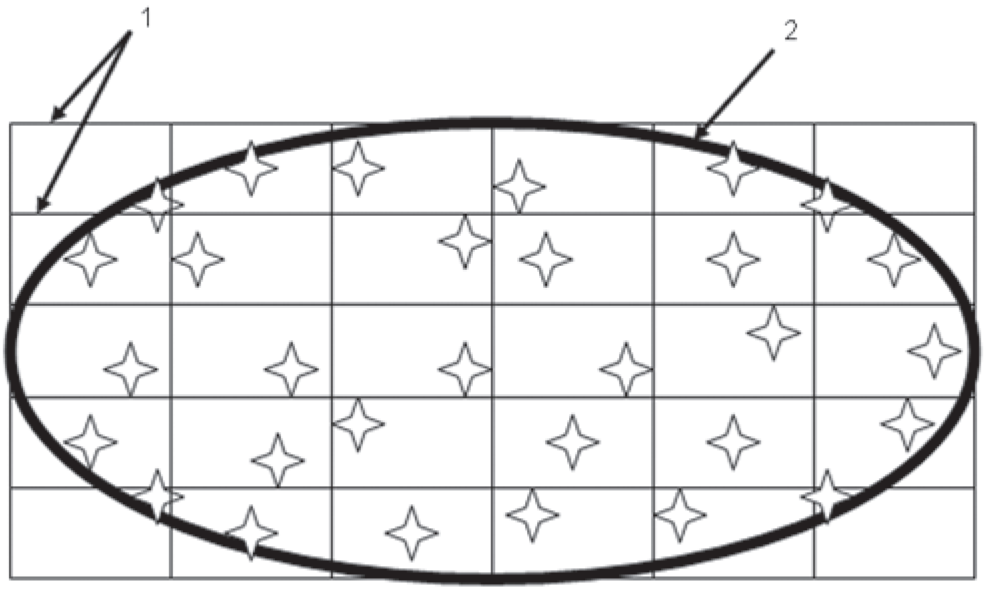


Figure L.2 — Stratified sampling in a production period

L.3 Stratified random sampling

Figure L.3 shows how the increments can be located over static lot if stratified random sampling is applied. The stars show where an increment can be taken.



Key

1 boundaries strata

2 ground surface static lot

Figure L.3 — Stratified random sampling in a static lot

Figure L.4 shows how the increments can be located over lot which is specified as a certain production period if stratified random sampling is applied. The arrows show where an increment can be taken. T_0 is the starting time and t_{end} is the end time of the production period.

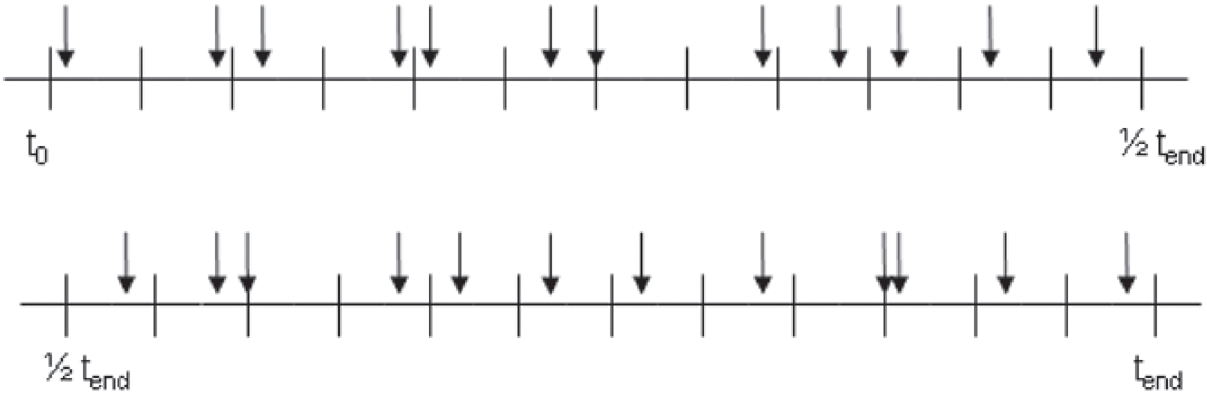


Figure L.4 — Stratified sampling in a production period

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