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**Solid recovered fuels — Methods for  
sampling**

*Combustibles solides de récupération — Méthodes d'échantillonnage*

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Published in Switzerland

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 300, *Solid recovered fuels*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

The testing of solid recovered fuels (SRF) 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 fulfil them, are detailed in an overall sampling plan. After a sampling plan has been prepared, the sampling of SRF itself can be implemented.

This document is largely based on the work already done by CEN/TC 292 “*Characterization of waste*” (now integrated in CEN/TC 444 “*Environmental characterization of solid matrices*”), in particular EN 14899:2005<sup>[1]</sup> and CEN/TR 15310-1:2006<sup>[2]</sup>.

The main characteristic that makes SRF samples significantly different from other kinds of waste is that SRFs are very often solid, but neither “granular” nor monolithic; it often happens that SRF samples are fibrous-like materials. This typical characteristic of SRF implies that the statistical formula for sampling of EN 14899:2005 and CEN/TR 15310-1:2006, Annex D are not applicable without amendment. The “shape factor” ( $f$ ) is additionally needed in the statistical formula.

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

Sampling of solid biofuels is described in ISO 18135<sup>[3]</sup>.

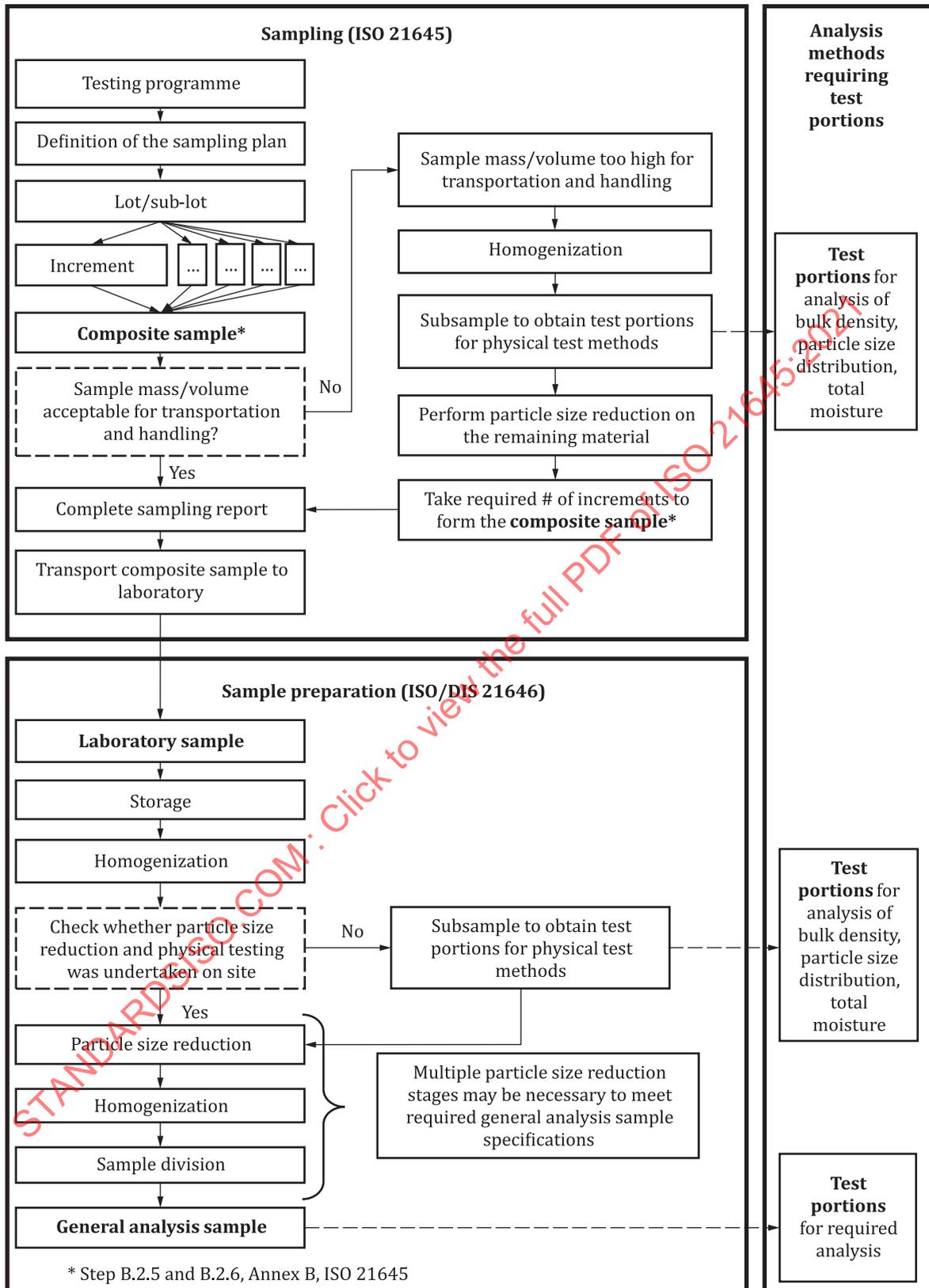


Figure 1 — Links between the essential elements of a testing program

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# Solid recovered fuels — Methods for sampling

## 1 Scope

This document 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 21637, *Solid recovered fuels — Terminology, definitions and descriptions*

ISO 21640:—<sup>1)</sup>, *Solid recovered fuels — Specifications and classes*

ISO 21644, *Solid recovered fuels — Methods for the determination of biomass content*

ISO 21654, *Solid recovered fuels — Determination of calorific value*

ISO 21656, *Solid recovered fuels — Determination of ash content*

ISO 21660-3, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 3: Moisture in general analysis sample*

ISO 21663, *Solid recovered fuels — Methods for the determination of carbon (C), hydrogen (H) and nitrogen (N) content*

ISO 22167, *Solid recovered fuels — Determination of the content of volatile matter*

EN 15408, *Solid recovered fuels — Method for the determination of sulphur (S), chlorine (Cl), fluorine (F) and bromine (Br) content*

EN 15410, *Solid recovered fuels — Method for the determination of the content of major elements (Al, Ca, Fe, K, Mg, Na, P, Si, Ti)*

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)*

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

EN 15415-2, *Solid recovered fuels — Determination of particle size distribution — Part 2: Maximum projected length method (manual) for large dimension particles*

EN 15415-3, *Solid recovered fuels — Determination of particle size distribution — Part 3: Method by image analysis for large dimension particles*

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

CEN/TR 15404, *Solid recovered fuels — Methods for the determination of ash melting behaviour by using characteristic temperatures*

1) Under preparation. Stage at the time of publication ISO/FDIS 21640.

CEN/TS 15405, *Solid recovered fuels — Determination of density of pellets and briquettes*

CEN/TS 15406, *Solid recovered fuels — Determination of bridging properties of bulk material*

CEN/TS 15412, *Solid recovered fuels — Methods for the determination of metallic aluminum*

CEN/TS 15414-1, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 1: Determination of total moisture by a reference method*

CEN/TS 15414-2, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 2: Determination of total moisture by a simplified method*

CEN/TS 15639, *Solid recovered fuels — Determination of mechanical durability of pellets*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21637 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

**3.1**  
**coefficient of variation**  
estimate of the standard deviation of a population from a *sample* (3.28) of *n* results divided by the mean of that sample

Note 1 to entry: The coefficient of variation is frequently stated as a percentage.

Note 2 to entry: Adapted from Eurachem/Citac Guide CG 4<sup>4</sup>.

**3.2**  
**composite sample mass**  
amount of *sample* (3.28) taken from a *lot* (3.11) or a *sub-lot* (3.40) consisting of all the *increments* (3.9)

**3.3**  
**distribution factor**  
correction factor for the *particle size distribution* (3.20) of the material to be sampled

[SOURCE: ISO 21637:2020, 3.17]

**3.4**  
**drop flow**  
material flow falling over an overflow point or a drop point in a transport system

[SOURCE: ISO 21637:2020, 3.18]

**3.5**  
**duplicate sample**  
two *samples* (3.28) taken under comparable conditions

Note 1 to entry: This selection may be accomplished by taking units adjacent in time or space.

Note 2 to entry: The replicate sample is usually used to estimate sample variability.

[SOURCE: ISO 21637:2020, 3.23, modified – Note 2 to entry has been added.]

**3.6**  
**general analysis sample**  
*sub-sample* (3.41) of a *laboratory sample* (3.10) having a nominal top size of 1 mm or less and used for a number of chemical and physical analyses

**3.7****heterogeneity**

degree to which a property or type of particle of a *solid recovered fuel* (3.34) is not uniformly distributed throughout a quantity of material

[SOURCE: ISO 21637:2020, 3.36]

**3.8****homogeneity**

degree to which a property or type of particle of a *solid recovered fuel* (3.34) is uniformly distributed throughout a quantity of material

[SOURCE: ISO 21637:2020, 3.37]

**3.9****increment**

portion of *solid recovered fuel* (3.34) extracted from a *lot* (3.11) or *sub-lot* (3.40) in a single operation of the *sampling* (3.30) device

[SOURCE: ISO 21637:2020, 3.39]

**3.10****laboratory sample**

composite *sample* (3.28) received by the laboratory on which *sample preparation* (3.29) procedures for analysis are undertaken

Note 1 to entry: When the laboratory sample is further prepared by mixing, subdividing, particle size reduction or by combinations of these operations, the result is the general analysis sample. A test portion is removed from the general analysis sample for the performance of the test or for analysis. When no preparation of the laboratory sample is required, the test portion may be taken directly from the laboratory sample.

**3.11****lot**

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

Note 1 to entry: A lot may be divided into sub-lots.

[SOURCE: ISO 13909-1:2016, 3.16<sup>[5]</sup>]

**3.12****mechanical durability**

ability of densified fuels to remain intact during handling and transportation

Note 1 to entry: Typical measures of resistance are shock and/or abrasion as a consequence of handling and transportation processes, characterized by disintegration and fines formulation.

Note 2 to entry: Examples are briquettes and pellets.

[SOURCE: ISO 21637:2020, 3.41]

**3.13****minimum increment mass**

minimum dimension or mass of the increment that is taken from a *lot* (3.11) in a single operation of the *sampling* (3.29) device from the point of view of preserving its representativeness

**3.14****minimum sample mass**

minimum amount or dimension of the sample required during *sampling* (3.30) and *sample preparation* (3.29) from the point of view of preserving its representativeness

Note 1 to entry: The minimum sample mass is at least equal to the increment mass multiplied by the number of increments, and is linked directly to the nominal top size.

**3.15**  
**moisture**

water removable under specific conditions

Note 1 to entry: See also *total moisture* (3.43).

[SOURCE: ISO 21637:2020, 3.46, modified – Note 1 to entry has been added.]

**3.16**  
**nominal minimum size**

$d_{05}$   
smallest aperture size of the sieve used for determining the *particle size distribution* (3.20) of solid fuels through which at least 5 % by mass of the material passes

**3.17**  
**nominal top size**

$d_{95}$   
smallest aperture size of the sieve used for determining the *particle size distribution* (3.20) of *solid recovered fuels* (3.34) through which at least 95 % by mass of the total material passes through the sieve

[SOURCE: ISO 21637:2020, 3.48]

**3.18**  
**particle density**  
density of a single particle

Note 1 to entry: Pores within the particle are included.

[SOURCE: ISO 21637:2020, 3.52]

**3.19**  
**particle size**  
size of the fuel particles as determined in a solid fuel

Note 1 to entry: Different methods of determination can give different results.

Note 2 to entry: See also *particle size distribution* (3.20).

**3.20**  
**particle size distribution**  
proportions of various *particle sizes* (3.19) in a solid fuel

**3.21**  
**particle size reduction**  
reduction of the *nominal top size* (3.17) of a *sample* (3.28) or *sub-sample* (3.41)

**3.22**  
**planned increment mass**  
planned dimension or mass of the *increment* (3.9) that is taken from a *lot* (3.11) in a single operation of the *sampling* (3.30) device

**3.23**  
**planned sample mass**  
*sample* (3.28) amount or dimension that is planned to be taken during *sampling* (3.29)

Note 1 to entry: The planned sample mass is derived from the minimum sample mass and includes additional considerations regarding the sampling procedure, practical handling and storage and the required sample amounts for analysis.

Note 2 to entry: The planned sample mass can be equal to the minimum sample mass.

### 3.24 precision

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

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

Note 2 to entry: 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 to entry: Quantitative measures of precision depend critically on the stipulated conditions.

[SOURCE: ISO 3534-2:2006, 3.3.4<sup>[6]</sup>, modified – Second sentence of Note 3 to entry has been removed.]

### 3.25 producer

organization or unit responsible for the production of *solid recovered fuel* (3.34)

Note 1 to entry: The producer can also be the supplier of the fuel.

Note 2 to entry: The producer may not directly produce or process non-hazardous waste into solid recovered fuel but may receive material appropriate to its requirements and already meeting the minimum criteria of ISO 21640:—.

[SOURCE: ISO 21637:2020, 3.60]

### 3.26 random sampling

taking a *sample* (3.28) at a random location within a specified range or from a specified *lot* (3.11) such that every portion of the *solid recovered fuel* (3.34) would have the same chance of being part of the sample

Note 1 to entry: A random location is determined by lot.

### 3.27 replicate sampling

taking of *increments* (3.9) at intervals, which are combined in rotation into different containers to give two or more *samples* (3.28) of approximately equal mass

Note 1 to entry: The replicate sampling is usually used to estimate sample variability.

### 3.28 sample

quantity of material, from a larger amount for which the quality is to be determined

Note 1 to entry: See also *increment* (3.9).

[SOURCE: ISO 21637:2020, 3.63, modified – Note 2 and 3 to entry have been removed.]

### 3.29 sample preparation

actions taken to obtain representative *laboratory sample* (3.10) or *test portions* (3.42) from the original sample as received

[SOURCE: ISO 21637:2020, 3.66]

### 3.30 sampling

process of drawing or constituting a *sample* (3.28)

[SOURCE: ISO 21637:2020, 3.68]

**3.31**

**sampling plan**

predetermined procedure for the selection, withdrawal, preservation, transportation and preparation of the portions to be removed from a population as a *sample* (3.28)

[SOURCE: ISO 21637:2020, 3.70]

**3.32**

**sampling record**

report which serves as a check list and provides the investigator with all necessary information about the *sampling* (3.30) techniques applied at the site and any additional important information

[SOURCE: ISO 11074:2015, 4.4.26<sup>[7]</sup>, modified – Part of definition has been removed as irrelevant to the context of this document.]

**3.33**

**shape factor**

factor that corrects the *minimum sample mass* (3.14) if the particles in a lot have not a regular shape (e.g. spherical or cubic)

[SOURCE: ISO 21637:2020, 3.72]

**3.34**

**solid recovered fuel**

solid fuel for energy purposes according to ISO 21640:— derived from non-hazardous waste

Note 1 to entry: A number of terms can be used to describe fuels from waste that might (but not always) qualify as solid recovered fuels. For example, refuse derived fuel, refuse derived paper and plastics densified fuel, waste derived fuel, shredded light fraction, sewage sludge, end of life wood, fuel composed of either municipal solid waste, industrial waste, commercial waste, construction and demolition waste, animal waste (e.g. meat and bone meal).

Note 2 to entry: This definition does not consider the value of the waste.

Note 3 to entry: Whether the input material is hazardous or non-hazardous is determined through national laws and directives or by categorization of the fuel through the annexes in the Basel Convention on the control of transboundary movements of hazardous wastes and their disposal.

[SOURCE: ISO 21637:2020, 3.75]

**3.35**

**specification**

document stating requirements

Note 1 to entry: See also *specification of solid recovered fuels* (3.36).

[SOURCE: ISO 9000:2015, 3.8.7<sup>[8]</sup>, modified - Example and notes to entry have been removed/replaced.]

**3.36**

**specification of solid recovered fuels**

list of properties that characterize *solid recovered fuel* (3.34)

Note 1 to entry: A template for such specification is given in ISO 21640:—.

[SOURCE: ISO 21637:2020, 3.76, modified – Note 1 to entry has been added.]

**3.37**

**static lot**

*lot* (3.11) that is not in motion during the *sampling* (3.30), or transported by a conveyor or alternative transport system

[SOURCE: ISO 21637:2020, 3.77]

**3.38****stratified random sampling**

stratified *sample* (3.28) constituting by increments which are taken randomly within each stratum

**3.39****stratified sampling**

*sampling* (3.30) constituting by increments taken from identified subparts (strata) of the parent population

Note 1 to entry: Definition derived from 'stratified sample' as defined in ISO 21637:2020, 3.78.

**3.40****sub-lot**

part of a *lot* (3.11) for which a test result is required

[SOURCE: ISO 21637:2020, 3.81]

**3.41****sub-sample**

portion of a *sample* (3.28)

Note 1 to entry: A sub-sample is obtained by procedures in which the items of interest are randomly distributed in part of equal or unequal size.

Note 2 to entry: A sub-sample may be either a portion of the sample obtained by selection or division of the sample itself, or the final sample of a multistage sample preparation.

[SOURCE: ISO 21637:2020, 3.82]

**3.42****test portion**

*sub-sample* (3.41) either of a *laboratory sample* (3.10) or a test sample required for the specific measurement

Note 1 to entry: The test portion can be taken from the laboratory sample directly if no preparation of sample is required (e.g. for bulk density determination or particle size distribution).

[SOURCE: ISO 21637:2020, 3.83, modified – Note 1 to entry has been added.]

**3.43****total moisture****moisture content**

moisture in a fuel measured under specific conditions on as received basis

**3.44****trueness**

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

Note 1 to entry: The measure of trueness is usually expressed in terms of bias.

Note 2 to entry: Trueness is sometimes referred to as "accuracy of the mean". This usage is not recommended.

Note 3 to entry: In practice, the accepted reference value is substituted for the true value.

Note 4 to entry: The determination of the exact trueness for waste and from waste derived materials such as solid recovered fuels is by definition not possible.

[SOURCE: ISO 3534-2:2006, 3.3.3, modified - Note 4 to entry has been added.]

**4 Symbols**

For the purposes of this document, the following symbols apply.

$b$	is the breadth of the flow, in m
$C_V$	is the coefficient of variation
$d_{05}$	is the nominal minimum size of a particle, in mm
$d_{95}$	is the nominal top size of a particle, in mm
$f$	is the shape factor, in $m^3/m^3$
$G$	is the conveyor load, in kg/m
$g$	is the correction factor for distribution in the particle size
$m$	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
$V$	is volume, in $m^3$
$v$	is conveyor velocity, in m/s
$\Phi_d$	is the drop flow, in kg/s
$\lambda_b$	is the bulk density of the solid recovered fuel, in $kg/m^3$
$\lambda_p$	is the particle density, in $kg/m^3$

## 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

The sampling plan shall be drawn up before the sampling takes place. Samples shall be taken representatively from a pre-defined lot of solid recovered fuel on the basis of this 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. The procedure specified in [Annex A](#) and the sampling plan presented in [Annex B](#) shall be used. [Annex C](#) provides an example of a sampling plan. 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 estimates 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 2](#) shows the actions that are necessary for the development of a sampling plan.

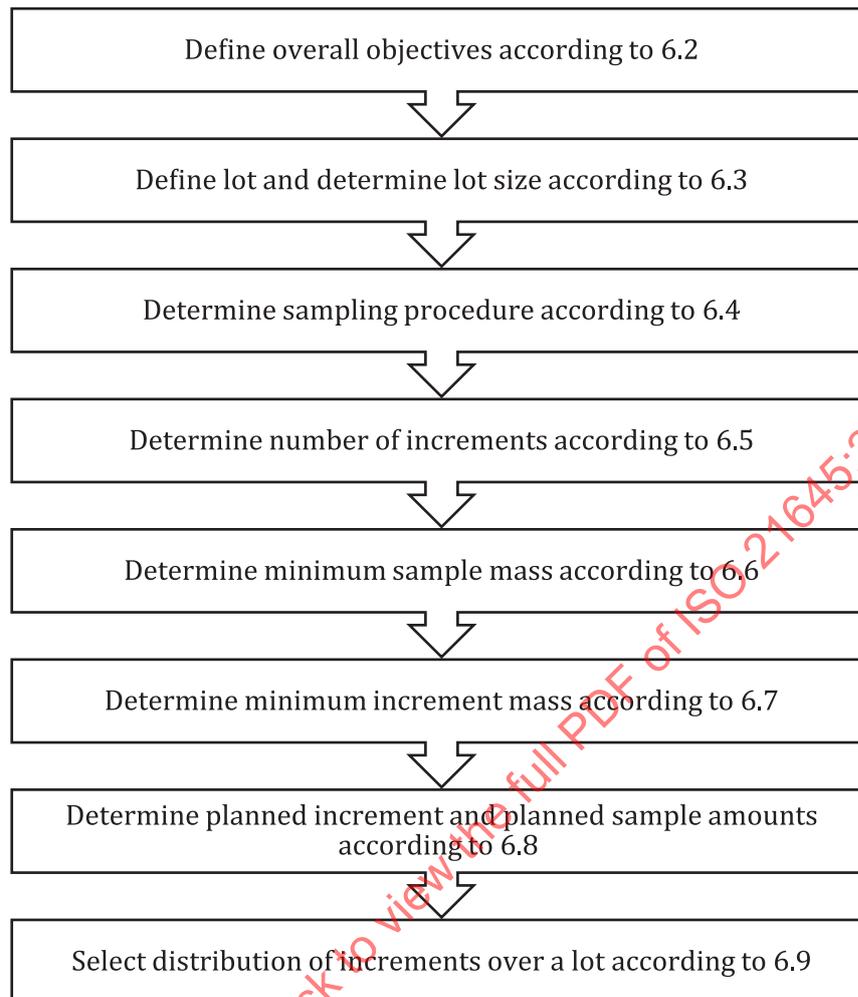


Figure 2 — Necessary elements for the development of a sampling plan

## 6.2 Definition of overall objectives

The sampling plan shall specify the objectives of the sampling program through consultation with all relevant parties. Parties that can be relevant are the client, the producer of the solid recovered fuel, the sampler or authorities. The sampling plan shall meet the requirements of objectives.

NOTE Examples of objectives for sampling are to determine the fuel quality, to get information for processing plant control, to estimate potential emission risks or to determine the necessary parameters for claiming renewable energy subsidies.

The sampling plan(s) shall identify any special precautions to be followed to minimize working hazards related to the sampling.

## 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

$1,5 \times 10^6$  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.

NOTE It is not always necessary to sample every lot in a production period. The sampling frequency is usually given by specific agreements with contractors and/or regulators.

### 6.3.2 Definition of a lot in case of 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 comprise the contents of the entire series of one or more vehicles used to transport the lot. A vehicle can be both a lorry or a railway wagon.

### 6.3.4 Definition of a lot in case of transport by ship

The total lot shall comprise to the contents of the entire series of material with the same specifications as agreed on in a contract of one or more ships used to transport the lot.

A lot can also relate to the quantity of material that is transported and delivered by separate compartments in the ship and by different specifications agreed on in a contract. If one ship contains several lots (i.e. 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 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 applied sampling method shall result in a representative sample from the lot. Therefore, sampling from a moving transport medium is preferred. The following sampling methods are available and shown in the order of preference, in which the methods shall be used (i.e. representativeness of sample decreases from top to bottom of this list):

- a) mechanically from a drop flow, for which the method specified in Annex H.4 shall be used;
- b) mechanically from a moving conveyor, for which the method specified in Annex H.5 shall be used;
- c) manually from a stationary conveyor, for which the method specified in Annex H.6 shall be used;
- d) manually from a drop flow, for which the method specified in Annex H.4 shall be used;
- e) manually from a vehicle, for which the method specified in [Annex I](#) shall be used;
- f) from a (temporary) store, for which the method specified in [Annex I](#) shall be used.

A less representative method shall only be chosen, if a more representative one is not possible in the existing situation.

## 6.5 Determination of the number of increments

The number of increments shall be at least 24.

**EXAMPLE** This means that for a lot size of 120 t an increment is taken on the average every 5 t and for a lot size of 1 320 t an increment is taken on the average every 55 t.

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

- if more sample material is required, e.g. for duplicate analyses or as contra sample to be stored;
- if it is easier to stratify the lot in different number of strata, e.g.  $5 \times 5 = 25$  strata.

**NOTE** The number of increments was fixed to 24 based on practical considerations. The main reason for this choice is the large differences that exist between solid recovered fuels. It seemed not very practical to calculate the number of increments for each situation before starting with sampling. More backgrounds on this choice can be found in the QUOVADIS reports<sup>[10,11]</sup>.

## 6.6 Determination of minimum sample mass

The minimum sample mass shall be determined according to the specifications in [Annex E](#). The minimum sample mass shall be reported in the sampling plan.

## 6.7 Determination of the minimum increment mass

### 6.7.1 Determination of minimum increment mass for material flows

If samples are taken from a material flow or from a conveyor, the minimum increment mass shall be determined using the instructions in [Annex F](#) in which a distinction is made between the following situations for the purposes of determining the increment mass:

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

**NOTE** For the purposes of determining the planned increment mass, 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 mass for static lots, vehicles or ships

If samples are taken from static lots, vehicles (e.g. lorry, heavy goods vehicle, railway wagon) or ships, the minimum increment mass shall be determined using the instructions in [Annex G](#).

## 6.8 Determination of the planned increment and planned sample amounts

The planned sample mass is preferably at least equal to the minimum sample mass to ensure representative samples from a statistical point of view. Practical considerations to obtain a workable sample mass can lead to deviations from this starting point. In case of sampling fluff-type solid recovered fuel from static lots, the planned sample mass is determined from the planned increment mass multiplied with 24 increments which leads to higher sample masses (composite sample mass) than the calculated minimum sample mass.

[Annex J](#) shall be used to verify whether the minimum sample mass ([6.6](#)) is at least large enough to perform all necessary analyses on the sample. The planned sample mass can be equal to the minimum sample mass when the requirements from [Annex J](#) are also fulfilled and can be larger than the minimum sample mass when additional sample is required. The planned sample mass shall be reported in the sampling plan.

**NOTE** Additional sample mass can be required in case duplicate analysis is wanted, when contra samples are needed or other needs.

The planned sample mass or volume can become impractical in situations where the estimated minimum sample mass or the minimum increment mass is such that the planned sample mass becomes practically unfeasible. When the estimated minimum sample volume (derived from the minimum sample mass in [Annex E](#)) becomes larger than 500 l (depending on the bulk density this will result in approximately 50 kg to 160 kg), the sampling procedure and/or the subsequent sample preparation (see ISO 21646:—<sup>2)</sup>[9]) can be seriously hampered by the practical constraints of handling and transporting such volumes or masses. Therefore, the planned sample volume of solid recovered fuel may be reduced to at least 500 l in cases where the estimated minimum sample volume (derived from the minimum sample mass) is larger than 500 l. The sampling plan shall clearly mention this deviation and state that the testing results can as a consequence be less representative of the lot.

Alternatively, sample preparation (e.g. shredding) on-site as shown in [Figure 1](#) can be considered to preserve the representativeness and to overcome the practical constraints of handling and transporting large volumes of sample to the laboratory. The on-site particle size reduction enables the sub-sampling of substantially smaller amounts that can be packed and transported to the laboratory.

## 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 are available and shown in the order of preference, in which the methods shall be used (i.e. preference of sampling method decreases from top to bottom of this list):

- a) stratified random sampling;
- b) stratified sampling.

“Stratified” means that a quantity of material (expressed as a mass or a volume) or a time interval is divided into a specific number of equal strata (sections). [Annex L](#) shows examples of sampling for clarification.

### 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. The following approach applies:

- a) the lot shall be defined either 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) the defined period shall be divided by the number of 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. The following approach applies:

- 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 vehicles shall at least be the minimum number of increments;

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2) Under preparation. Stage at the time of publication: ISO/DIS 21646:2021.

- d) if it is possible and sufficiently safe for the sampler to do so, this increment can be taken directly from the vehicle. If this is not possible, the increment can 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, the increments shall be taken 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** A lot of  $3 \times 10^6$  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  $1,5 \times 10^6$  kg. The quantity above the maximum permitted lot size will be regarded, for sampling purposes, as a new lot or sub-lot. The total lot of  $3 \times 10^6$  kg is therefore split into two separate sub-lots for sampling of  $1,5 \times 10^6$  kg each. For each sub-lot of  $1,5 \times 10^6$  kg, the minimum number of increments that are taken is 24. Sampling requires the following steps:

- 1) The weight of the total lot is  $3 \times 10^6$  kg. For sampling purposes, this is regarded as two sub-lots weighing  $1,5 \times 10^6$  kg each. The first sub-lot will be transported by a series of 60 lorries.
- 2) At least 24 increments are taken for each sub-lot of  $1,5 \times 10^6$  kg. 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.
- 3) The increment is 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 are at least equal to the already determined increment mass.

Steps 1 to 3 are completed again for the sampling process involving the second sub-lot of  $1,5 \times 10^6$  kg.

**NOTE 1** If for example two increments are taken from each of the lorry, it is 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 or static lot (see Annex D).

**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 are taken per vehicle.

#### 6.9.4 Implementation of sampling from a static lot

The following approach for the implementation of sampling from a static lot or store shall be applied:

- 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** A lot of solid recovered fuel of  $1 \times 10^6$  kg, which is to be sampled, has a volume of 3 000 m<sup>3</sup>. The lot is 60 m long, 40 m wide and 1,25 m high. 24 increments are taken from the lot. The sampling process requires the following steps:

- 1) The surface area of the lot is 2 400 m<sup>2</sup>, 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<sup>2</sup>);

- 2) For each stratum of 100 m<sup>2</sup>, 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.

## **6.10 Sampling equipment and implements**

Appropriate sampling equipment to achieve representative samples shall be selected in accordance with [Annex D](#).

## **7 Implementation of the sampling plan**

### **7.1 Steps before actual sampling**

The following steps shall be taken by the sampler before the actual sampling:

- a) Check all relevant data in the sampling plan.
- b) Check 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 minimum sample mass and increment mass shall be determined and mentioned in deviations;
- c) Check the lot size. If the lot size deviates from the sampling plan, the sampling plan shall be adjusted;
- d) Ensure the lot does not originate from two or more different lots. If the lot originates 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, report and sufficiently justify these adjustments in the sampling report.

### **7.2 Steps during sampling**

The following steps shall be taken during sampling:

- a) If sample is taken manually, take the increment in one movement and ensure 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) Ensure the sampling is representative and independent instead of results orientated. In every case, remove the upper surface of the material to be sampled to avoid material that has dried and/or become contaminated.
- c) If during the performance of the sampling anything is performed that deviates from the sampling plan, report and sufficiently justify this deviation in the sampling report (in the section for deviations).

### **7.3 Steps after sampling**

The following steps shall be taken after sampling:

- a) finish the sampling plan, to be done by the sampler;
- b) close and sufficiently label the sampling containers.

## 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 cold and dry room, wrapped and kept in tightly sealed non-transparent packaging. The samples shall not be exposed to sunlight. If the dimensions of the (sub-)samples are larger than 1 m<sup>3</sup>, tight sealing is not practically feasible and the (sub-)samples should be preferably kept in a cold and dry room. If the size of samples is too large, they may be kept in a dark and dry room. The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material.

Homogenization and sample size reduction can be considered according to ISO 21646:— . Samples should be stored at maximum 5 °C for no longer than one week. If longer time for storing is required and/or when the samples cannot be stored at maximum 5 °C, the samples should be pre-dried according to ISO 21646:— to avoid problems with moisture (e.g. drying effect and micro-organisms decomposing the sample). Storage conditions shall be reported in the sampling record. Analysis for total moisture, self-heating characteristics and biomass content shall not be undertaken on pre-dried samples.

## 9 Precision

The test 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 sampling has been acquired through the validation investigation within the European project "QUOVADIS". The results of QUOVADIS provide information on the uncertainty of the sampling method. Data on the precision of the method for sampling of solid recovered fuels is shown in informative [Annex K](#). The results of QUOVADIS cannot be available as normative data on the precision of the sampling for the following reasons:

- 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 is required for each specific matrix and therefore each type of solid recovered fuel.

## Annex A (normative)

### Procedure for the development of a sampling plan

#### A.1 General

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

#### A.2 Principle

The sampling plan shall be developed in accordance with [A.3](#), which specifies a procedure for the development of sampling plan in nine parts with 27 steps.

#### A.3 Procedure

##### Part 1 Defining lot and lot size

- 1) What form does the solid recovered fuel have (e.g. fluff, pellets, bales, powder)? Make a note.
- 2) From which company does the lot of solid recovered fuel come? 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) Which components does the solid recovered fuel contain (e.g. plastics, paper, wood, organic material, sand), and what is the nominal top size of these components? The producer's data, analysis or expert judgement can be used for this. Make a note.
- 10) What is the dominant shape of the particles with the nominal top size (e.g. flat pieces or more or less granular)? Make a note.
- 11) What is the bulk density of the solid recovered fuel? The producer's data, analysis or expert judgement can be used for this. Make a note.
- 12) What is the average particle density of the components of the solid recovered fuel? The producer's data, analysis or expert judgement can be used for this. Make a note.

#### Part 4 Determination of minimum increment mass, planned increment mass, minimum sample mass and planned sample mass

- 13) Using the data from parts 1, 2 and 3, determine the minimum (6.7) and planned increment masses (6.8) in kg and l. Make a note. Clearly report any deviations.
- 14) Using the data from parts 1, 2 and 3, determine the minimum sample masses according to 6.6. Determine the planned sample mass according to 6.8 taking into account any reserve samples, duplicate samples or countercheck samples and practical considerations with regard to manageable sample masses/volumes. Make a note. Both minimum and planned sample mass shall be reported. Clearly report any deviations.

#### 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 interval, 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. Instructions on homogenization and sample reduction are given in ISO 21646:—.

#### Part 9 Storing sample

- 27) The samples shall be kept in a cold and dry room, wrapped and kept in tightly sealed non-transparent packaging. The samples shall not be exposed to sunlight. If the dimensions of the (sub-) samples are larger than 1 m<sup>3</sup>, tight sealing is not practically feasible and the (sub-)samples should

be preferably kept in a cold and dry room. If the size of samples is too large, they may be kept in a dark and dry room. The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material. Homogenization and sample size reduction can be considered according to ISO 21646:—. Samples should be stored at maximum 5 °C for no longer than one week. If longer time for storing is required and/or when the samples cannot be stored at maximum 5 °C, the samples should be pre-dried according to ISO 21646:— to avoid problems with moisture (e.g. drying effect and micro-organisms decomposing the sample). Storage conditions shall be reported in the sampling record. Analysis for total moisture, self-heating characteristics and biomass content shall not be undertaken on pre-dried samples.

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## Annex B (normative)

### Sampling plan

#### B.1 General

This annex specifies the sampling plan that shall be used and completed. An example of a completed sample plan is provided in [Annex C](#).

#### B.2 Form for the sampling plan

##### 1) General information

Project (number)		
Name of project leader		
Telephone		
E-mail address		
Name of sampler and company		
Telephone		
E-mail address		
Sampling date		
Sampling location		
Street		
Town/city		
Contact on site		
Telephone		
Origin of solid recovered fuel		Specifications of the origin can be found in ISO 21640:—, Table 3.
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 in <a href="#">Annex A</a> )
Lot size dimension	kg m <sup>3</sup>	(follows from step 3 in <a href="#">Annex A</a> )  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?	<input type="checkbox"/> mechanical sampling from the drop flow <input type="checkbox"/> mechanical sampling from the conveyor belt <input type="checkbox"/> manual sampling from the conveyor belt <input type="checkbox"/> sampling from one or more vehicles <input type="checkbox"/> sampling from a static lot	(follows from step 4 to step 8 in <a href="#">Annex A</a> )
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**4) Information on solid recovered fuel**

Bulk components		(follows from step 9, <a href="#">Annex A</a> )
Nominal top size	mm	(follows from step 9, <a href="#">Annex A</a> )
Dominant shape of particles with nominal top size		(follows from step 10, <a href="#">Annex A</a> )
Bulk density	kg/m <sup>3</sup>	(follows from step 11, <a href="#">Annex A</a> )
Particle density	kg/m <sup>3</sup>	(follows from step 12, <a href="#">Annex A</a> )

**5) Information on increment and sample amounts<sup>a</sup>**

What is the minimum increment mass?	-	kg	(follows from step 13 in <a href="#">Annex A</a> )
	-	l	
What is the minimum sample mass?	-	kg	(follows from step 14 in <a href="#">Annex A</a> )
	-	l	
What is the planned increment mass?	-	kg	(follows from step 13 in <a href="#">Annex A</a> )
	-	l	
What is the planned sample mass?	-	kg	(follows from step 14 in <a href="#">Annex A</a> )
	-	l	

<sup>a</sup> The composite sample mass (i.e. the result of sampling and combining the increment masses) shall be reported in the sampling record.

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

How many increments are required?		(follows from step 15 in <a href="#">Annex A</a> )		
Increments	Times (follow from step 16 to step 18 in <a href="#">Annex A</a> )	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 22 and 24 to 25, <a href="#">Annex A</a> ).		
		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 ( $d_{95}$ ) ≤ 30 mm	<input type="checkbox"/> Yes. If possible, decrease the size of each sample to the minimum sample mass for the $d_{95}$ concerned. <input type="checkbox"/> No. 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 mass for the $d_{95}$ concerned <sup>a</sup> . ISO 21646:— can be used for instructions on homogenization and sample reduction.	(follows from step 27 in <a href="#">Annex A</a> )
<sup>a</sup> The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material. 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.		

**8) Deviations detected**

<p>All deviations regarding this document introduced in the sampling plan shall be reported and sufficiently justified.</p> <p>All deviations regarding the sampling plan encountered in the field operation shall be reported and sufficiently justified.</p> <p>If sufficiently motivated, reporting deviations helps to understand why a higher quality sample cannot be taken under the given circumstances.</p>
--

**9) Approval of sampling plan and sampling record**

	Name	Signature	Date
Project leader			

	Name	Signature	Date
Sampler			

**Appendices**

- 1) Calculating increment and sample masses
- 2) Photos of the location/position of random check lots/sampling
- 3) .....

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## Annex C (informative)

### Example of a sampling plan

#### C.1 General

This annex provides an example of a completed sampling plan in accordance with [Annex B](#).

#### C.2 Example of completed sampling plan

##### 1) General information

Project (number)	SOC 09/2019	
Name of project leader	Jon Smith	
Telephone	+44 07484 123456	
E-mail address	smith@company.uk	
Name of sampler and company	Jim Walker, SOCOTEC UK Ltd	
Telephone	+44 07803 554400	
E-mail address	walker@socotec.uk	
Sampling date	2019-12-09	
Sampling location	Jones & Co. Ltd	
Street	Midway Road	
Town/city	Burton on Trent, Staffordshire	
Contact on site	Mr A N Other	
Telephone	+44 07803 123456	
Origin of solid recovered fuel	5. Non-hazardous municipal solid waste or similar non-hazardous commercial waste	Specifications of the origin can be found in ISO 21640:—, Table 3.
Description of material for sampling	< 300 mm RDF (dimensions ~270 mm × 270 mm × 50 mm)	
Measurement objective	To determine the bulk density, particle size distribution, total moisture, net caloric value and chlorine	The objective is the reason why a sample is taken.

##### 2) Definition of lot and lot size

Form taken by solid recovered fuel	Loose material having undergone a primary shred to reduce the large particle size.	(follows from step 1 in <a href="#">Annex A</a> )
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Origin of solid recovered fuel	Deliveries from waste handling station		(follows from step 2 in <a href="#">Annex A</a> )
Lot size dimension	This sample lot will represent road deliveries made to site in a single day.	kg m <sup>3</sup>	(follows from step 3 in <a href="#">Annex A</a> )  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?	<input type="checkbox"/> mechanical sampling from the drop flow <input type="checkbox"/> mechanical sampling from the conveyor belt <input type="checkbox"/> manual sampling from the conveyor belt <input type="checkbox"/> sampling from one or more vehicles <input checked="" type="checkbox"/> sampling from a static lot	(follows from step 4 to step 8 in <a href="#">Annex A</a> )
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### 4) Information on solid recovered fuel

Bulk components	Broken plastics, thin plastic bags / packaging, pieces of wood, organic matter, broken glass.		(follows from step 9 in <a href="#">Annex A</a> )
Nominal top size	300	mm	(follows from step 9 in <a href="#">Annex A</a> )
Origin of data	Data from producer		
Dominant shape of particles with nominal top size	Long and thin (sticky pieces). Flat amorphous plastic shapes		(follows from step 10 in <a href="#">Annex A</a> )
Bulk density	225	kg/m <sup>3</sup>	(follows from step 11 in <a href="#">Annex A</a> )
Origin of data	Expert judgement		
Particle density	1 000	kg/m <sup>3</sup>	(follows from step 12 in <a href="#">Annex A</a> )
Origin of data	Expert judgement		

### 5) Information on increment and sample amounts<sup>a</sup>

What is the minimum increment mass?	164	kg	(follows from step 13, <a href="#">Annex A</a> )
	729	l	
What is the minimum sample mass?	859	kg	(follows from step 14, <a href="#">Annex A</a> )
	3 817	l	

<sup>a</sup> The composite sample mass (i.e. the result of sampling and combining the increment masses) shall be reported in the sampling record.

What is the planned increment mass?	4,7 21	kg l	(follows from step 13 in <a href="#">Annex A</a> )
What is the planned sample mass?	113 500	kg l	(follows from step 14 in <a href="#">Annex A</a> )
<sup>a</sup> The composite sample mass (i.e. the result of sampling and combining the increment masses) shall be reported in the sampling record.			

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

How many increments are required?	24	(follows from step 15 in <a href="#">Annex A</a> )		
Increments	Increments to be taken from deliveries arriving throughout the day to make a single composite sample comprising 24 increments. Establish no. of deliveries and divide by the no. of increments to identify the interval.../... or randomly select 8 deliveries taking 3 increments from each.	Each delivery has 3 increments selected from the fuel following discharge onto the floor. Each increment is collected using a front end loading shovel which deposits the increment into a designated sample collection area where it can be mixed and sub-divided prior to being transferred into sample containers to be shipped to the laboratory or it could be shipped to the laboratory without sub-division.  However, due to the excessive sample size obtained from x24 increments the sub-division procedure is adopted on site to reduce the mass retained (see 6.8). This can be done using the strip sampling sub-division procedure to reduce the sample mass by the required ratio to give adequate mass to undertake all the required analyses.		
		X coordinate	Y coordinate	Z coordinate
Increment number 1	- Delivery No.2	Randomly selected from the discharged load		
Increment number 2	- Delivery No.2			
Increment number 3	- Delivery No.2			
Increment number 4	- Delivery No.5	Randomly selected from the discharged load		
Increment number 5	- Delivery No.5			
Increment number 6	- Delivery No.5			
Increment number 7	- Delivery No.6	Randomly selected from the discharged load		
Increment number 8	- Delivery No.6			
Increment number 9	- Delivery No.6			
Increment number 10	- Delivery No.9	Randomly selected from the discharged load		
Increment number 11	- Delivery No.9			
Increment number 12	- Delivery No.9			
...continue to Increment No. 24	- Delivery No. ....	Continue as above for a further 4 deliveries		

**7) Storage**

Nominal top size ( $d_{95}$ ) $\leq$ 30 mm	<input type="checkbox"/> Yes. If possible, decrease the size of each sample to the minimum sample mass for the $d_{95}$ concerned. <input checked="" type="checkbox"/> No. 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 mass for the $d_{95}$ concerned <sup>a,b</sup> .	Thorough mixing of increments on site shall be undertaken prior to any sub-division to produce the sample to be returned to the laboratory for further sample preparation procedures.
<sup>a</sup> The effective dimensions are determined by the maximum permitted quantity prescribed for the determination concerned and the minimum required quantity of sample material.		
<sup>b</sup> 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.		

**8) Deviations detected**

Sub-division of the obtained composite sample on site following completion of sampling to provide a manageable sample volume (see 6.8). If the sample volume or mass is reduced, it will also reduce the representativity / precision of the sample taken from the sample lot.
All deviations regarding this document 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 reporting deviations helps to understand why a higher quality sample cannot be taken under the given circumstances.

**9) Approval of sampling plan and sampling record**

	Name	Signature	Date
Project leader			
Sampler			

**Appendices**

- 1) Calculating increment and sample masses
- 2) Photos of the location/position of random check lots/sampling



3) .....

## Annex D (normative)

### Sampling equipment and implements

#### D.1 General

This annex specifies the requirements for the sampling equipment.

#### D.2 Principle

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

#### D.3 Selection of an apparatus

The range of equipment that is available for sampling of solid recovered fuel (and other materials) is very large. Depending on the situation, different types of sampling equipment are possible. Sampling equipment to be selected shall meet the following three basic rules for sampling:

- a) the sampling equipment shall not contaminate or affect the sample taken from the solid recovered fuel;
- b) every particle shall have an equal chance of being sampled;
- c) the minimum dimensions of the sampling equipment shall be at least three times the nominal top size of the particles in the solid recovered fuel.

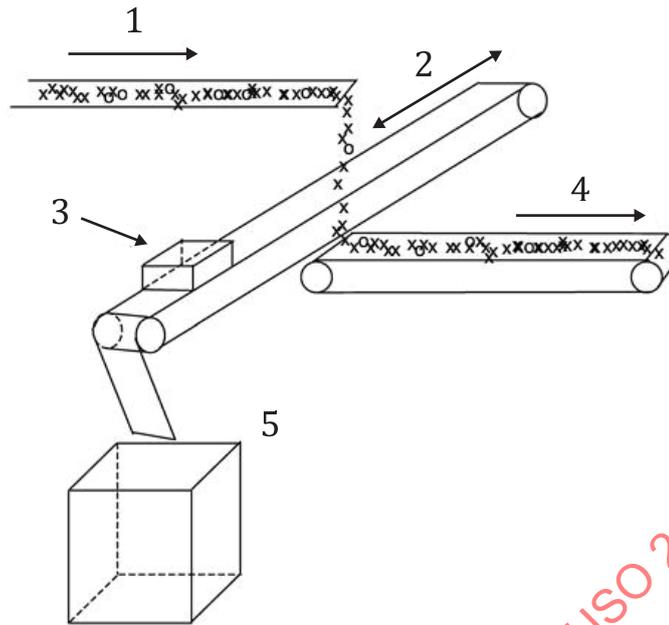
When choosing an implement or piece of equipment, the procedure that will be used for sampling shall be taken into account.

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

This subclause gives a number of examples of equipment for sampling from a moving conveyor or a drop flow. If other systems are used, the three basic rules as described in [D.3](#) for taking an increment are applicable as well. This requires that the whole stream should be covered.

Common designs of equipment include:

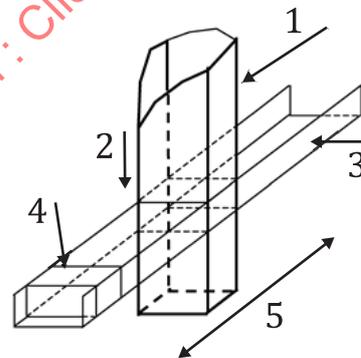
- a tray that moves through the drop flow via rail, motorised or otherwise (rail tray method, see [Figure D.1](#));
- a tray that is pulled like a drawer through a drop flow (drawer method, see [Figure D.2](#));
- a scoop or a flap, which may be mechanically driven, that is placed in the drop flow at the sampling time and passes completely through the stream depth, covering its full width when collecting without overflowing;
- a cross-belt sampler, which is an automatic device that enables sampling from a moving conveyor belt (see [Figure D.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 D.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 D.2 — Drawer method**

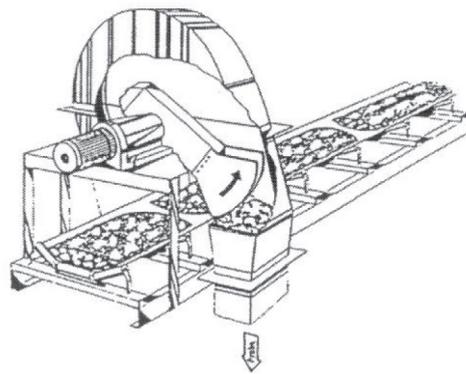


Figure D.3 — An example of a cross-belt sampler

## D.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 D.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.

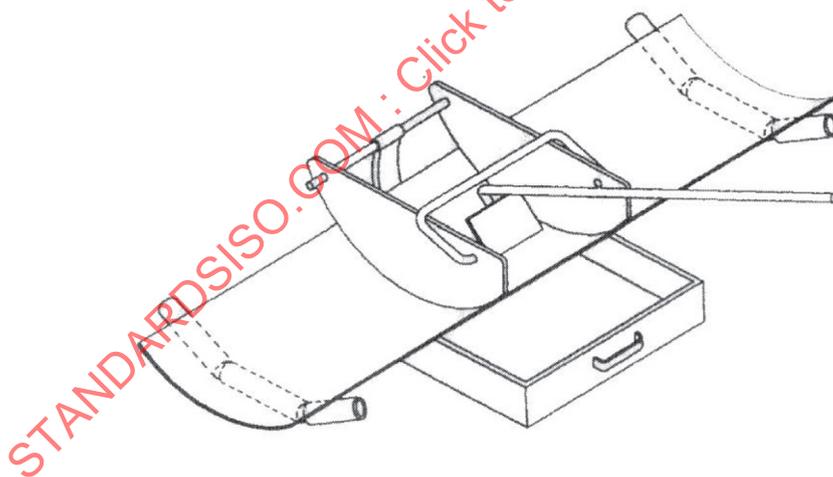


Figure D.4 — Sampling frame

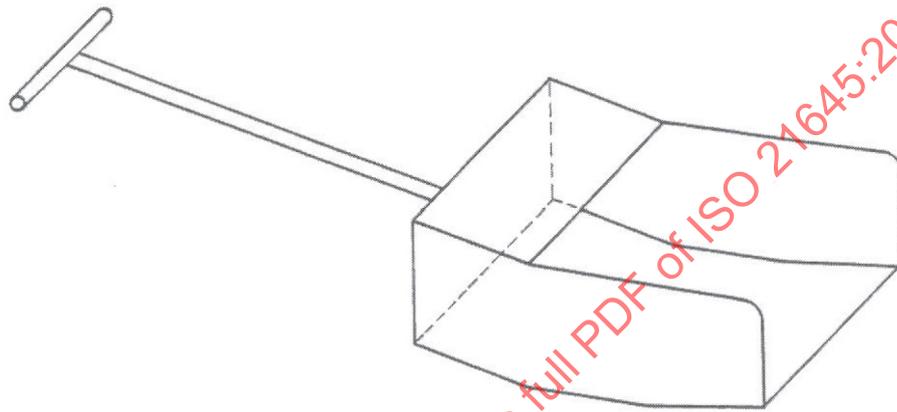
## D.6 Sampling scoop

Equipment that 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, taking into account the three basic rules for sampling equipment as described in [D.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 D.5](#) shows a scoop which has been designed for granular solid recovered fuels. [Figure D.6](#) shows a scoop which has been designed for fluff-type solid recovered fuels.

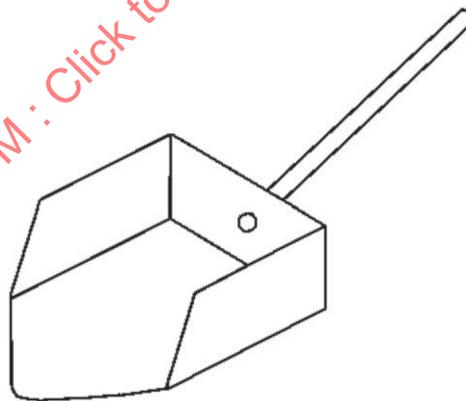
Example 1 shows how the required dimensions are determined for a sampling scoop that is used for granular solid recovered fuels. Example 2 shows the same for fluff-type solid recovered fuels.

**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  $\times$  60 mm  $\times$  60 mm. A sampling scoop like the one illustrated in [Figure D.5](#) can be used for this 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 is 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  $d_{95,l}$ ). Therefore, for fluff with a  $d_{95,l}$  of 200 mm, the dimensions of the sampling scoop ( $l \times b \times h$ ) are at least 600 mm  $\times$  600 mm  $\times$  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 D.6](#)).



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



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

## D.7 Shovels

A shovel can be designed as illustrated in [Figure D.7](#), conforming to the general requirements for equipment design.

**NOTE** A shovel is best for sampling from a stationary pile.

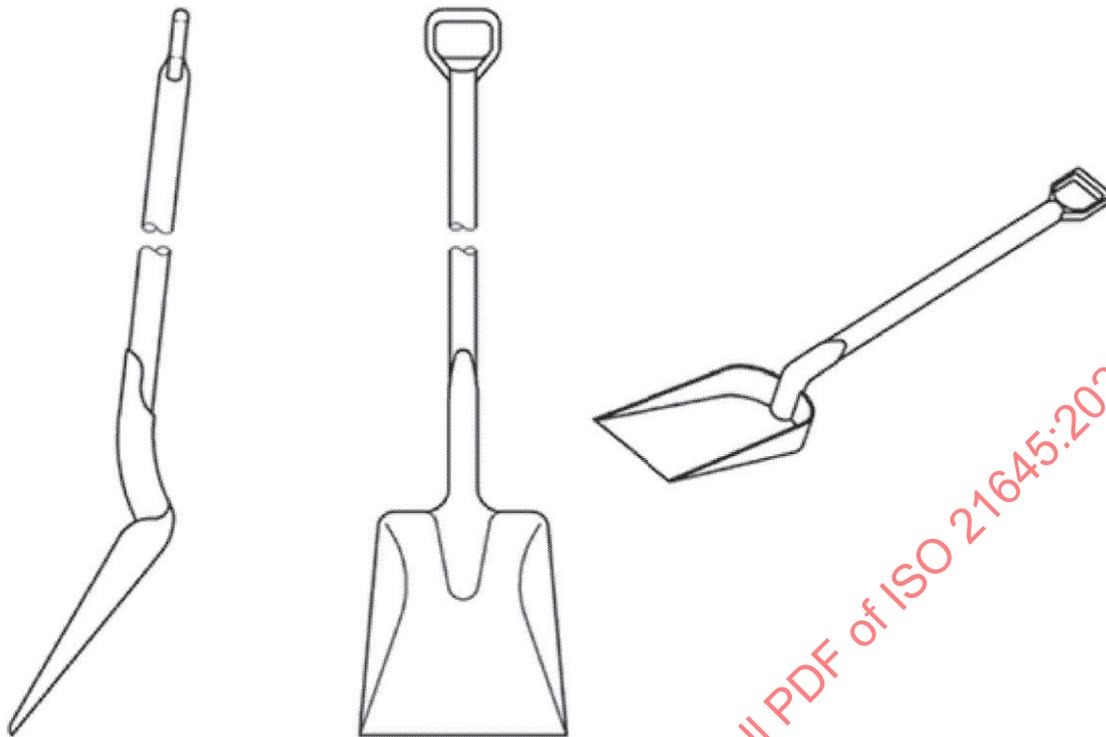
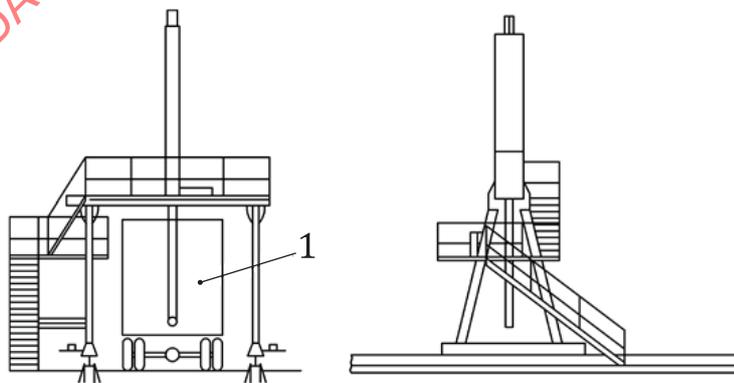


Figure D.7 — Example of a shovel

### D.8 Mechanical probe

Mechanical systems can be used for sampling from lorries or railway wagons. [Figure D.8](#) shows an example of a mechanical probe. Mechanical probes are suitable for materials with a nominal top size <math><25\text{ mm}</math>. The system shall be designed to prevent loss of moisture during sampling. The internal radius 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 document. The sampling points, and the depth from which each increment is taken, shall be chosen randomly. The mechanical probes provided with a drill can 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 D.8 — An example of a mechanical probe

## Annex E (normative)

### Determination of minimum sample mass

#### E.1 General

This annex specifies the determination of the minimum sample mass.

#### E.2 Principle

The minimum sample mass shall in principle be large enough to have enough particles from the lot being sampled in order to obtain a representative sample for the total lot. Solid recovered fuels can originate from a wide variety of waste materials that have undergone various treatments. Due to the largely unknown composition, particle sizes and density of solid recovered fuels, application of the basic principles for representative sampling for all sorts of solid recovered fuels would lead to sample masses that are not practically feasible. Therefore, the principles of representative sampling should be partly compromised to meet the practical boundary conditions for sampling and sample preparation of solid recovered fuels.

#### E.3 Determination of parameters necessary for the minimum sample mass

##### E.3.1 General

The following parameters shall be acquired to determine the minimum sample mass:

- the nominal top size of a particle,  $d_{95}$  (see [E.3.2](#));
- the shape factor  $f$  (see [E.3.3](#));
- the particle density  $\lambda_p$  and bulk density  $\lambda_b$  (see [E.3.4](#));
- the distribution factor  $g$  (see [E.3.5](#));
- the factor  $p$  (= the fraction of the particles with a specific characteristic, such as contaminant) (see [E.3.6](#));
- the coefficient of variation  $cv$  (see [E.3.7](#)).

##### E.3.2 Determination of the nominal top size

The nominal top size,  $d_{95}$ , shall be determined either as specified in EN 15415-1, by using the specifications from the producer, or by expert judgement of the sampler. The approach of definition of the nominal top size shall be documented in the sampling plan.

##### E.3.3 Determination of the shape factor

The shape factor shall be determined using sieving/manual sorting analyses of a sample using EN 15415 (all parts). Alternatively, a characterization study for the  $d_{95}$  particles of the solid recovered fuel can be performed to determine the shape factor. The dimensions ( $l \times b \times h$ ) and weight of individual  $d_{95}$  particles after sieving or manual sorting will then be determined. The approach and the assumptions shall be documented in the sampling plan. Expert judgement shall not be used to determine the shape factor.

The shape factor shall be determined by using [Formula \(E.1\)](#):

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

where

$f$  is the shape factor, in mm<sup>3</sup>/mm<sup>3</sup>;

$V_{95}$  is the maximum volume of a fluff particle (a mass fraction of 95 % of the particles are smaller than  $V_{95}$ ), in mm<sup>3</sup> (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  $d_{95,l}$ ), 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.

For materials which are more or less granular or have a nominal top size smaller than 50 mm, it 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 mass reduction will not outweigh the effort of determining the shape factor. Thus, if the shape factor is not determined, a value 1,0 shall be used.

### E.3.4 Determination of the particle density and bulk density

The particle density,  $\lambda_p$ , is the average particle density of the particles in the solid recovered fuel, in kg/m<sup>3</sup> as received. If the average particle density is not determined experimentally, a value of 1 000 shall be used.

The bulk density,  $\lambda_b$ , shall be determined either as specified in CEN/TS 15401, by using the specification according to ISO 21640:— from the producer, or by expert judgement of the sampler.

### E.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,  $d_{05}$ . The value for  $g$  to be used shall be deducted from [Table E.1](#).

**Table E.1 — Distribution factor**

Characteristic	Ratio $d_{95}/d_{05}$ <sup>a</sup>	$g$
Broad particle size distribution	$d_{95}/d_{05} > 4$	0,25
Medium particle size distribution	$2 \leq d_{95}/d_{05} \leq 4$	0,50
Narrow particle size distribution	$1 < d_{95}/d_{05} < 2$	0,75
Uniform particles	$d_{95}/d_{05} = 1$	1,00

<sup>a</sup>  $d_{05}$  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. When the factor  $g$  is not determined using the analyses of the nominal top size,  $d_{95}$ , and the minimum particle size,  $d_{05}$  using EN 15415 (all parts), a value for  $g$  of 0,25 shall be used. For pellets and briquettes, a value for  $g$  of 1,00 shall be used.

### E.3.6 The factor $p$

The factor  $p$  refers to the fraction of the particles with a specific characteristic (such as contaminants). A fixed value of 0,10 shall be used for this factor.

### E.3.7 The coefficient of variation $cv$

A coefficient of variation  $cv$  of 0,1 shall be used.

## E.4 Calculation of the minimum sample mass

### E.4.1 General

The parameters defined in [E.3](#) shall be used to calculate the minimum sample mass using [Formula \(E.2\)](#).

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

where

$m_m$  is the mass of the minimum sample mass, in kg 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 solid recovered fuels are of the fluff type, the value for  $d_{95,1}$  can be used. For granular materials, both the  $d_{95}$  of the particles in the pellets and the  $d_{95}$  of the pellets themselves can be used.

$f$  is the shape factor, in  $\text{mm}^3/\text{mm}^3$ ; if the shape factor is not determined experimentally, a value of 1 shall be used;

$\lambda_p$  is the average particle density of the particles in the solid recovered fuel, in  $\text{kg}/\text{m}^3$  as received; if the average particle density is not determined experimentally, a value of 1 000 shall be used;

$g$  is the correction factor for distribution in the particle size; if the factor  $g$  is not determined experimentally, a value of 0,25 shall be used; for pellets and briquettes, a value for  $g$  of 1,00 shall be used.

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

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

In case the typical solid recovered fuels factors (i.e.  $f$ ,  $\lambda_p$ , and  $g$ ) have not been determined experimentally, the minimum sample mass can be estimated using either [Table E.2](#) for fluff-type solid recovered fuels or [Table E.3](#) for granular or pelletized solid recovered fuels.

### E.4.2 Quick determination of minimum sample mass for fluff-type solid recovered fuels

The minimum sample mass for fluff-type solid recovered fuels with irregular shaped particles as a function of the  $d_{95,1}$  is summarized in [Table E.2](#). This table can be applied in case the typical solid recovered fuels parameters (i.e.  $f$ ,  $\lambda_p$ , and  $g$ ) have not been determined experimentally. The only parameter that needs to be acquired is  $d_{95,1}$ . The value of  $d_{95,1}$  shall be determined either as specified in EN 15415-1, using the specifications from the producer, or by expert judgement of the sampler.

NOTE The minimum sample mass is the minimum amount from a statistical point of view to obtain a representative sample. The planned sample mass is described in [6.8](#) and is derived from the minimum sample mass. The planned sample mass or volume includes additional considerations regarding the sampling procedure, practical handling and storage and the required sample amounts for analysis ([Annex J](#)).

**Table E.2 — Determination of the minimum sample mass of fluff-type solid recovered fuels as function of the  $d_{95,l}$ <sup>a</sup>**

$d_{95,l}$ <sup>b</sup> mm	Bulk density kg/m <sup>3</sup>	50	75	100	125	150	175	200	225	250	275	300
	Minimum sample mass kg	Minimum sample volume <sup>c</sup> l										
<b>50</b>	0,8	16	11	8	6	5	5	4	4	3	3	3
75	2,5	50	33	25	20	17	14	12	11	10	9	8
<b>100</b>	6	120	79	59	47	39	34	29	26	24	21	20
<b>125</b>	12	230	150	120	92	77	66	58	51	46	42	38
150	20	400	270	200	160	130	110	99	88	80	72	66
200	47	940	630	470	380	310	270	240	210	190	170	160
250	92	1 800	1 200	920	740	610	530	460	410	370	330	310
300	159	3 200	2 100	1 600	1 300	1 100	910	800	710	640	580	530

<sup>a</sup> Table E.2 can be used when determining the minimum sample mass for fluff-type solid recovered fuels. The following parameters were used at a standard (mostly worst-case) value: particle density of 1 000 kg/m<sup>3</sup>, 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.

<sup>b</sup> The  $d_{95,l}$  values in bold represent the standard sieve size apertures according to EN 15415-1.

<sup>c</sup> Green colour indicates that sample volume is feasible in practice, orange colour means that sample volume can put more requirements on handling, and red colour indicates that sample volume is unrealistic in practice.

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

- the density (particle density) amounts to 1 000 kg/m<sup>3</sup>;
- the bulk density amounts to 80 kg/m<sup>3</sup>;
- $V_{95}$  amounts to 95 000 mm<sup>3</sup>;
- $d_{95}$  amounts to 190 mm, and  $d_{05}$  amounts to 50 mm;
- $d_{95,l}$  amounts to 200 mm;
- the shape factor  $f$  then amounts to  $95\ 000/200^3 = 0,011\ 9$ ;
- the ratio  $d_{95,l}/d_{05,l}$  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 and applying Formula (E.2), this leads to a minimum sample mass with a weight of  $\pi/(6 \times 10^3) \times (190)^3 \times 0,011\ 9 \times 1\ 000 \times 0,50 \times (1-0,1)/(0,1^2 \times 0,1) = 19,19$  kg, and a volume of  $19,19/80 \times 1\ 000 = 240$  l for the fluff-type solid recovered fuel concerned.

### E.4.3 Quick determination of minimum sample mass for granular solid recovered fuels

The minimum sample mass for granular solid recovered fuels with regular shaped particles (e.g. pellets) as a function of the  $d_{95}$  is summarized in Table E.3. This table can be applied in case the typical solid recovered fuels parameters (i.e.  $f$ ,  $\lambda_p$ , and  $g$ ) have not been determined experimentally. The only parameter that needs to be acquired is  $d_{95}$ . The value of  $d_{95}$  shall be determined either as specified in EN 15415-1, using the specifications from the producer, or by expert judgement of the sampler.

NOTE The minimum sample mass is the minimum amount from a statistical point of view to obtain a representative sample. The planned sample mass is described in 6.8 and is derived from the minimum sample mass. The planned sample mass or volume includes additional considerations regarding the sampling procedure, practical handling and storage and the required sample amounts for analysis (Annex I).

Table E.3 — Determination of the minimum sample mass of granular solid recovered fuels

$d_{95}$ <sup>b, c</sup> mm	Bulk density kg/m <sup>3</sup>	50	75	100	125	150	175	200	225	250	275	300
	Minimum sample mass kg	Minimum sample volume <sup>d</sup> l										
10	0,8	15	10	8	6	5	4	4	3	3	3	3
<b>12,5</b>	0,9	18	12	9	7	6	5	5	4	4	3	3
20	4	75	50	38	30	25	22	19	17	15	14	13
<b>25</b>	7	150	98	74	59	49	42	37	33	29	27	25
30	13	250	170	130	100	85	73	64	57	51	46	42
40	30	600	400	300	240	200	170	150	130	120	110	100
<b>50</b>	59	1 200	790	590	470	390	340	290	260	240	210	200

NOTE Table E.3 can be used when determining the minimum sample mass for granular solid recovered fuels with a density (particle density) of 1 000 kg/m<sup>3</sup>, a shape factor  $f$  and a distribution factor  $g$  of 1,0, a factor  $p$  and a coefficient of variation  $cv$  of 0,1.

<sup>b</sup> The  $d_{95}$  values in bold represent the standard sieve size apertures according to EN 15415-1.

<sup>c</sup> The  $d_{95}$  values can affect both the  $d_{95}$  of the particles in the pellets and the  $d_{95}$  of the pellets themselves.

<sup>d</sup> Green colour indicates that sample volume is feasible in practice, orange colour means that sample volume can put more requirements on handling, and red colour indicates that sample volume is unrealistic in practice.

EXAMPLE A granular solid recovered fuel consisting of pellets has a particle density of 1 000 kg/m<sup>3</sup> and a bulk density of 700 kg/m<sup>3</sup>. Approximately a mass fraction of 95 % of the pellets has a diameter of 20 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 mass with a weight of  $1,0 \times \pi / (6 \times 10^9) \times 20^3 \times 1,0 \times 1\,000 \times (1 - 0,1) / (0,1^2 \times 0,1) = 3,768$  kg, and a volume of  $3,768 / 700 = 0,005\,383$  m<sup>3</sup> = 5,38 l.

## Annex F (normative)

### Determination of increment mass for sampling from material flows

#### F.1 General

This annex specifies the determination of the increment mass for sampling from material flows. Distinction is made for the following situations:

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

#### 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. In case of 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.

#### F.3 Determination of increment mass for mechanical sampling from a drop flow

For mechanical sampling from a drop flow, the breadth of the increment shall be equal to at least three times the  $d_{95}$  of the material for sampling.

The mass of the increment mass shall be calculated using [Formula \(F.1\)](#):

$$m_i = \phi_d \frac{b}{v_c} \quad (\text{F.1})$$

where

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

$\phi_d$  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 increment mass can be calculated using [Formula \(F.2\)](#):

$$m_m = 5\phi_d \frac{d_{95}}{1\,000} \quad (\text{F.2})$$

where

$m_m$  is the mass of the increment mass, in kg;

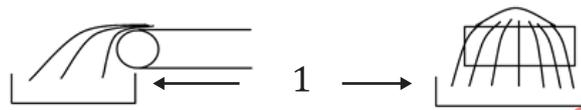
$\Phi_d$  is the drop flow, in kg/s;

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

[Formula \(F.2\)](#) 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.

#### F.4 Determination of increment mass 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 F.1](#)).



##### Key

1 collection tray

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

Assuming 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 compared with the time when the material flow falls entirely into the collection tray, the mass of the increment mass conforms to [Formula \(F.3\)](#):

$$m_i = \phi_d \times t_m \quad (\text{F.3})$$

where

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

$\Phi_d$  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 to meet the minimum sample mass.

Assuming that the collection tray is moved through the drop flow at a constant velocity, the mass of the increment mass conforms to [Formula \(F.4\)](#):

$$m_i = \phi_d \frac{b_s}{v_c} \quad (\text{F.4})$$

where

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

$\Phi_d$  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 m;

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

[Formula \(F.4\)](#) 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.

## F.5 Determination of increment mass for sampling from a conveyor

For determining the increment mass 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, the following requirements apply:

- the breadth of the increment shall be equal to at least three times the  $d_{95}$  of the material for sampling;
- 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.

The increment mass shall be determined by using [Formula \(F.5\)](#):

$$m_m = b \times G = \frac{3 \times d_{95} \times G}{1\ 000} \quad (\text{F.5})$$

where

$m_m$  is the mass of the increment mass, 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.

## Annex G (normative)

### Determination of increment mass for sampling from static lots, vehicles or ships

#### G.1 General

This annex specifies the determination of the increment mass for sampling from static lots, vehicles or ships.

#### G.2 Principle

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

#### G.3 Procedure

The increment mass 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. The mass of the increment mass for solid recovered fuels shall be determined by using [Formula \(G.1\)](#):

$$m_m = 2,7 \times 10^{-8} \times d_{95}^3 \times \lambda_b \quad (\text{G.1})$$

where

$m_m$  is the mass of the increment mass, in kg;

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

$\lambda_b$  is the bulk density, in kg/m<sup>3</sup>.

## Annex H (normative)

### Implementation of sampling plan from a material flow

#### H.1 General

This annex specifies the performance of the implementation of sampling from a material flow. Sampling from a material flow can be performed in the following three situations:

- a) mechanical or manual sampling from the drop flow (see [H.4](#));
- b) mechanical sampling from a moving conveyor (see [H.5](#));
- c) manual sampling from a stationary conveyor (see [H.6](#)).

These situations are described in separate procedures, which describe the performance of the sampling for the specific situation.

#### H.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 are not neglected.

#### H.3 Procedure verification of sampling aspects

The following aspects shall be taken into account 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 including 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.

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

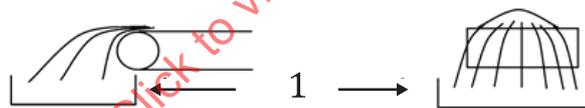
A collection tray shall be used for both mechanical and manual sampling from the drop flow. The following steps shall be completed to implement either mechanical or manual sampling from the drop flow:

- a) Ensure that the collection tray satisfies 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 H.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) Ensure that the collection tray moves through the entire flow at a constant velocity when taking the sample of a drop flow. Ensure that all locations from the cross-section of the drop flow are 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 H.2](#) is a schematic drawing of the taking of an increment.

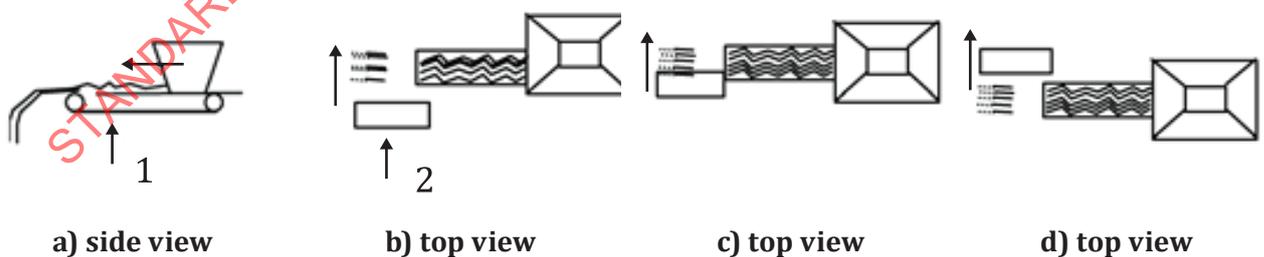
- c) Choose a constant velocity that enables a sufficiently large increment to be taken.
- d) Take the increments at the times determined in the sampling plan, in which the times shall preferably be drawn in a stratified random way.
- e) Check whether the increment mass of each increment is equal to the calculated increment mass by weighing or by volume (see [E.3](#) and [E.4](#)).
- f) Put the increments (at least 24 for a lot weighing  $1,5 \times 10^6$  kg) together to form one composite sample. Check whether the minimum or planned sample masses are satisfied by weighing or by volume (see [Table E.2](#) or [Table E.3](#) taking into account the requirements according to [6.8](#)). The minimum and planned sample mass shall be reported.
- g) Describe all actions taken and all relevant deviations from the sampling plan on the sampling record.



**Key**

- 1 collection tray

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



**Key**

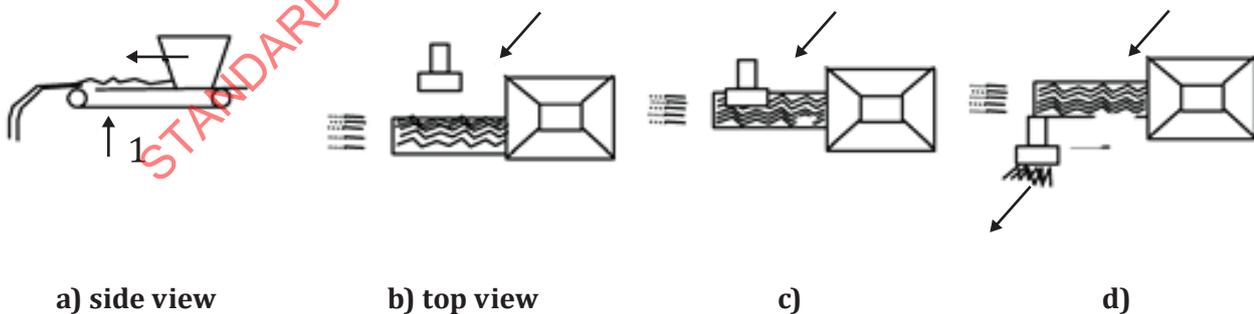
- 1 transport system  
2 collection tray

**Figure H.2 — Schematic representation of sampling from drop flow**

**H.5 Procedure: Mechanical sampling from a moving conveyor**

The following steps shall be completed for mechanical sampling from a moving conveyor:

- 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 H.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, put the mechanical sampling into action at the times drawn.
- c) Check whether the taken increment mass of each increment is at least equal to the calculated increment mass by weighing or by volume (see [E.5](#)).
- d) Put the increments (at least 24 for a lot weighing  $1,5 \times 10^6$  kg) together to form one composite sample. Check whether the minimum or planned sample masses are satisfied by weighing or by volume (see [Table E.2](#) or [Table E.3](#) taking into account the requirements according to [6.8](#)). Report the minimum and planned sample mass.
- e) Describe all actions taken and all relevant deviations from the sampling plan on the sampling record.



**Key**  
 1 transport system

**Figure H.3 — Schematic representation of sampling from the conveyor**