
Solid recovered fuels — Specifications and classes

Combustibles solides de récupération — Spécifications et classes

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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).

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).

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.

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.

Introduction

The objective of this document is to provide a common classification and specification system for solid recovered fuels (SRF) to enable efficient trading of SRF, to promote their safe use in energy conversion activities and to increase the public trust. The document facilitates a good understanding between seller and buyer, supports purchase, trans border movements, use and supervision as well as an effective communication with equipment manufacturers. The classification and specification system support authority permission procedures and ease the reporting on environmental issues.

SRF are produced from non-hazardous waste. The input waste can be production specific waste, municipal solid waste, industrial waste, commercial waste, construction and demolition waste, sewage sludge etc. It is thus obvious that SRF are a heterogeneous group of fuels. A well-defined system for classification and specification is therefore of significant importance to reach the above-mentioned objectives and intentions.

This document covers all types of SRF and will thus have a wide field of application. The aim of producing a solid recovered fuel is to use it for energy purposes at the highest possible energy efficiency.

This document describes the compliance rules for SRF according to this classification system. Classification enables statistical information of SRF properties in the market, thus increasing transparency in the use of non-hazardous waste in SRF and demonstrating development of this business field.

This document also describes how the supplier can establish specifications and a declaration of conformity to the different ISO standards for SRF.

It is important to emphasise that despite the standardisation of SRF, the standard should not be interpreted as end-of-waste criteria. Such criteria can be set at national or regional levels, but then in legislation and not in this document. Also, it should be noted that the waste used for the SRF production should be such waste streams that are not suitable for re-use, preparation for re-use or efficient material recycling.

[Figure 1](#) illustrates a simplified flow chain for SRF, from input of non-hazardous waste to end use of SRF. This document has an interface to all the stages in the chain, from point of acceptance to point of delivery. The fuel is not considered an SRF until it is specified and classified according to this document. Requirements for how the input waste is collected and how to use the SRF are not part of this document.

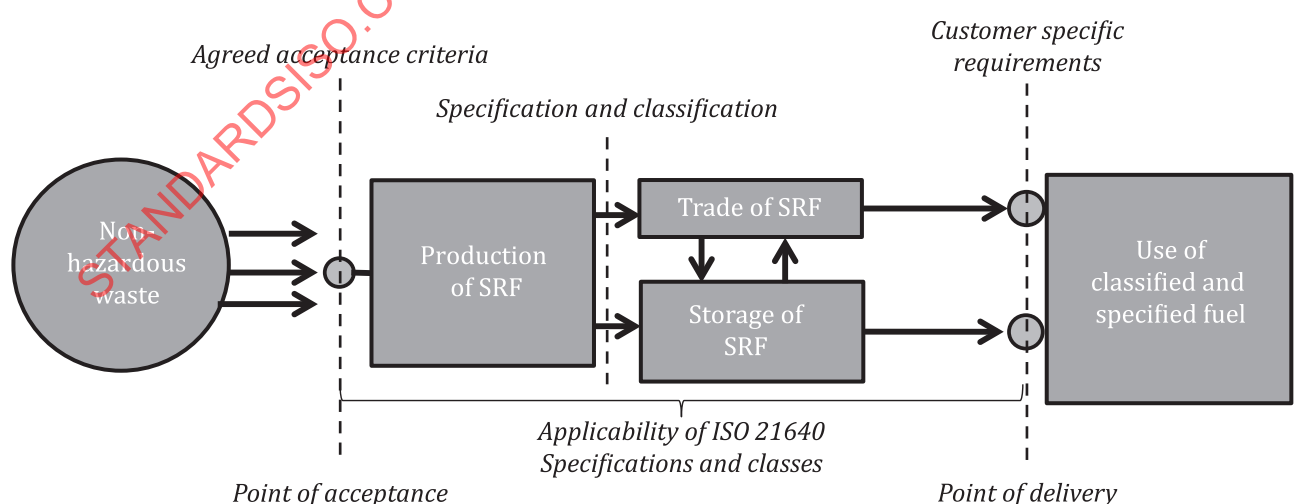


Figure 1 — Solid recovered fuels chain – This document on specifications and classes is applicable after production up to the point of delivery

NOTE This document is applicable to trading and storage of SRF. However, if during storage or trade the SRF is mixed with other SRF or other fuels, then the classification and specifications are no longer valid. If sold further, then the mixing would constitute an SRF production.

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Solid recovered fuels — Specifications and classes

1 Scope

This document specifies a classification system for solid recovered fuels (SRF), and a template containing a list of characteristics for the specification of their properties, enabling trade and use of SRF supporting the protection of the environment.

SRF are produced from non-hazardous waste.

NOTE 1 Untreated municipal solid waste as such cannot be considered SRF. Untreated municipal solid waste can however be feedstock to plants producing SRF.

NOTE 2 Chemically treated solid biofuels that do not contain halogenated organic compounds or heavy metals at levels higher than those in typical virgin material, can be defined as solid biofuels and thus be part of the standard series ISO 17225^[1].

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 — Vocabulary*

ISO 21645, *Solid recovered fuels — Methods for sampling*

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*

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

classification of solid recovered fuels

categorizing of solid recovered fuels into classes focusing on the key properties – NCV, Cl and Hg that are defined by boundary values

3.2

specification of solid recovered fuels

list of properties that characterizes solid recovered fuels

Note 1 to entry: Templates for such specifications are given in [Annex A](#) in this document.

4 Symbols and abbreviations

The symbols and abbreviations used in this document comply with the SI system of units as far as possible.

Table 1 — Symbols and abbreviations

Symbol	Definition
(d)	dry (dry basis)
d_x	particle diameter where x denominates the share of particles passing through a sieve of that size
(ar)	as received
A	Designation for ash content on dry basis $A_{(d)}$ [% in mass]
ρ	Designation for bulk density as received [kg/m ³]
M	Designation for moisture content as received on wet basis, M_{ar} [% in mass]
P	Designation for the particle size of the main fraction (> 95 % in mass) related to size intervals.
NCV	Designation for net calorific value as received, $q_{p, net, ar}$ [MJ/kg or kWh/kg or MWh/t] at constant pressure
VM	Designation for volatile matter on dry basis [% in mass]

NOTE 1 MJ/kg equals 0,277 8 kWh/kg (1 kWh/kg equals 1 MWh/t and 1 MWh/t are 3,6 MJ/kg). 1 g/cm³ equals 1 kg/dm³. 1 mg/kg equals 0,000 1 % in mass.

5 Principles

The classification system is based on three important characteristics, referred to as the main SRF characteristics: an economic characteristic (net calorific value), a technical characteristic (chlorine content) and an environmental characteristic (mercury content). The characteristics are chosen to give a stakeholder an immediate but simplified picture of the fuel in question.

The classes also impose limitations on what can be called SRF restricting it with a minimum net calorific value as well as maximum values of chlorine and mercury. Fuel outside the ranges of the classes shall not be defined as SRF.

Only fuels derived from non-hazardous waste that meet the SRF ISO Standards can be classified as SRF.

The classification itself is not enough for an intending user or other stakeholders. The level of detailed information needed depends on several different factors. Such factors can be; the end use of the SRF, legislative demands, character of the input material, and the technology used either in production or end use of the SRF. Relevant fuel properties are thus to be given in the specification of the SRF. Some of the fuel properties are deemed so important that they are obligatory to specify whereas others can be recorded voluntarily, e.g. upon request of the user.

It is important that SRF meet specified quality requirements which are to be determined based on a defined lot size by a minimum number of measurements.

6 Classification

The classification system (Table 2) for SRF is based on limit values for three important fuel characteristics. These are the net calorific value (NCV); chlorine content (Cl); mercury content (Hg).

Due to the statistical distribution pattern of the characteristics the values shall be presented as:

- NCV (ar) mean (arithmetic);
- Cl (d) mean (arithmetic);
- Hg (ar) median and 80th percentile

The average, median, and percentiles are determined on the quantity of SRF as specified in [Clause 8](#).

NOTE 1 80th percentile is the value on or below which 80 % of the observations fall.

Not all kinds of SRF are suited for all types of energy recovery installations, see CEN/TR 15508^[2].

Each of the classification characteristic is divided into 5 classes. The SRF should be assigned a class number from 1 to 5 for each characteristic. A combination of the class numbers makes up a class code (see example below). The characteristics should be considered as equal important and thus no single class number determines the code. The class code shall be included in the specification as described in [Clause 9](#).

For mercury, the higher of the two statistical values (median and 80th percentile) in a Hg data set determines the class.

EXAMPLE An SRF with a median value of 0,03 and 80th percentile value of 0,07 belongs to Hg class 3 (according to [Table 2](#)).

NOTE 2 The performances of the plant where SRF is used are depending on the properties of the SRF and more significantly on the design and operating conditions of such a plant.

NOTE 3 The limit values used for different classes must not be mixed up with limit values set by the competent authority in an environmental permit or other equally binding documents.

NOTE 4 The specific transfer factor for mercury of a given process and the proportion of SRF will determine which classes can be used. Examples of transfer factors for existing processes are given in CEN/TR 15508^[2].

Table 2 — Classification for solid recovered fuels

Classification characteristic	Statistical measure	Unit	Classes				
			1	2	3	4	5
Net calorific value (NCV)	Mean	MJ/kg (ar)	≥ 25	≥ 20	≥ 15	≥ 10	≥ 3
Chlorine (Cl)	Mean	% in mass (d)	≤ 0,2	≤ 0,6	≤ 1,0	≤ 1,5	≤ 3
Mercury (Hg)	Median	mg/MJ (ar)	≤ 0,02	≤ 0,03	≤ 0,05	≤ 0,10	≤ 0,15
	80 th percentile	mg/MJ (ar)	≤ 0,04	≤ 0,06	≤ 0,10	≤ 0,20	≤ 0,30

7 Specifications

7.1 General

The SRF shall be specified according to the template in [Annex A](#). [Annex A](#) consists of properties that are obligatory to specify. If the producer and the end user have agreed upon additional properties to be specified, those should be documented in a similar way.

For specification of the properties in [Annex A](#), determination shall be made according to ISO test methods for SRF. Technical specifications or regional/national standards can be used if no ISO test method is available. For additional properties, ISO test methods are recommended but other relevant methods can be used. If other methods are used, it shall be stated in the SRF specification.

7.2 Origin

The specification of origin is based on the origin and source of waste input material as described in [Table 3](#). The material accepted for SRF production are those that are not suitable for material recycling. This can, as an example, include reject streams from packaging recycling/sorting. The main origin-based solid recovered grades are:

1. Non-hazardous industrial waste

There are several waste streams generated within industry and commerce that could be used to produce SRF. Different industrial sectors typically generate different kinds of wastes, like manure from agriculture or fibre reject streams from pulp and paper industry. For this reason, there are several subcategories ([Table 3](#)). However packaging waste are generated many different industries and commerce operations. In this case they are often quite similar and are thus not specified for individual industries. In this post is also included the packaging materials from construction projects.

2. Non-hazardous construction and demolition waste

Construction waste and demolition waste differ from each other because constructing means building something new while waste from demolition normally comes from old structures. In renovation projects, both construction and demolition typically take place simultaneously, and thus generates both types of waste. The waste from the construction and demolition industry used for SRF production are mainly different wood and plastic fractions although also bituminous mixtures considered as non-hazardous waste can be used. The possibility to source separate materials at construction and demolition sites can be limited thus often resulting in a mixed waste fraction.

3. Non-hazardous waste from waste management facilities

Waste received at waste management facilities are treated in diverse ways. It can be water treatment, composting, anaerobic treatment, sorting, crushing and densifying. When doing these treatments, the plants will end up with different waste streams aimed for recycling, recovery or disposal. Some of these can be used for the production of SRF.

4. Non-hazardous waste from material recycling facilities

During the recycling process, there will be material that does not fulfil the quality criteria. These reject streams can be potentially used for the production of SRF.

5. Non-hazardous municipal solid waste and similar non-hazardous commercial waste

Although an untreated mixed municipal waste stream could not be called SRF, it still can be sorted and used for the production of SRF. Municipal solid waste includes bulky waste and waste from gardens and parks as well as waste from markets. Source separated material streams (e.g. paper, plastics etc.) are not intended as direct input material for SRF production but are rather intended for material recycling. Reject from these kinds of materials can be found above under bullet 4 Non-hazardous waste from material recycling facilities.

6. Non-hazardous waste not otherwise specified in the list

If the waste origin is not covered in the above categories, it shall be declared here. The origin of the waste should be described as clearly as possible.

It is not unusual that waste fractions that are intended for production of SRF (or for combustion) are mixed during the logistic chain, thus there could be waste from different origins in the same transport. However, the principle is to give as much detail about the origin as possible. Thus, if waste has been collected from different industries (and not being packaging waste) then the separate codes of origins shall be stated according to [Table 3](#).

Table 3 — Sources of input material for the production of SRF

1. Non- hazardous industrial waste	1.1 wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing	1.1.1 plastic waste (except packaging)
		1.1.2 absorbed urine and manure (including spoiled straw), collected separately and treated off-site
		1.1.3 other non- hazardous waste
	1.2 wastes from pulp, paper and cardboard production and processing	1.2.1 mechanically separated rejects from pulping of waste-paper and cardboard
		1.2.2 fibre rejects, fibre-, filler- and coating-sludges from mechanical separation
		1.2.3 other non- hazardous waste
	1.3 waste from wood processing, production of panels and furniture	1.3.1 non-hazardous wood waste from chemically treated wood
		1.3.2 other non-hazardous waste
	1.4 wastes from the textile industry	1.4.1 waste from composite materials (impregnated textile, elastomer, plastomer)
		1.4.2 waste from unprocessed textile fibres
		1.4.3 waste from processed textile fibres
		1.4.4 other non- hazardous waste
	1.5 wastes from organic chemical processes	1.5.1 plastic waste (except packaging)
		1.5.2 solid wastes other than solid wastes containing hazardous substances
		1.5.3 other non- hazardous waste
	1.6 wastes from shaping and physical and mechanical surface treatment of plastics	
	1.7 packaging waste	1.7.1 paper and cardboard packaging
		1.7.2 plastic packaging
		1.7.3 wooden packaging
		1.7.4 composite packaging
		1.7.5 mixed packaging
		1.7.6 textile packaging
2. Non- hazardous construction and demolition waste	2.1 wood and plastic	2.1.1 wood
		2.1.2 plastic (except packaging)
	2.2 bituminous mixtures, coal tar and tarred products	2.2.1 bituminous mixtures that are not considered as hazardous waste
	2.3 other construction and demolition wastes	2.3.1 insulation materials (polyurethane and polystyrene)
		2.3.2 mixed construction and demolition waste
	3.1 wastes from aerobic treatment of solid wastes	3.1.1 non-composted fraction of municipal and similar wastes
		3.1.2 non-composted fraction of animal and vegetable waste
	3.2 wastes from anaerobic treatment of solid waste	3.2.1 non-digestible fraction of municipal, industrial and other waste
	3.3 sludge from wastewater treatment plants	3.3.1 sludge from treatment of urban wastewater
		3.3.2 other solid waste from treatment of urban wastewater
		3.3.3 sludge from treatment of industrial wastewater
		3.3.4 other non-hazardous solid waste from treatment of industrial wastewater

Table 3 (continued)

3. Non-hazardous waste from waste management facilities	3.4 wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising)	3.4.1 paper and cardboard waste
		3.4.2 textile waste
		3.4.3 wood waste
		3.4.4 plastic and rubber waste
		3.4.5 other non-hazardous wastes (including mixtures of materials) from mechanical treatment of wastes
	3.5 end-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance	3.5.1 end of life tyres
		3.5.2 plastic waste (except packaging)
		3.5.3 other non-hazardous waste from end-of-life vehicles
4 Non-hazardous waste from material recycling facilities	4.1 reject fractions from material recycling facilities, not otherwise mentioned	4.1.1 paper and cardboard waste
		4.1.2 textile waste
		4.1.3 wood waste
		4.1.4 plastic waste
		4.1.5 other non-hazardous waste from material recycling facilities
5. Non-hazardous municipal solid waste or similar non-hazardous commercial waste	5.1 residual municipal solid waste	
	5.2 bulky waste	5.2.1 wood waste
		5.2.2 plastic waste (except packaging)
		5.2.3 mixed combustible bulky waste
	5.3 other municipal solid waste or similar commercial waste	5.3.1 waste from markets
		5.3.2 park and garden waste
6 Non-hazardous waste not otherwise specified in the list	any non-hazardous waste that is not defined by the codes above, to be specified by the supplier	

NOTE 1 There can be national legislation demanding the use of national or regional waste catalogues/lists codes in the specification. In these cases, that information can also be stated in the specification table.

NOTE 2 Some waste streams of biomass origin can fulfil requirement for a solid biofuel and can be specified according to ISO 17225-1[1].

NOTE 3 The list of origins has been developed from the base of the European waste catalogue but been heavily modified and simplified to accommodate the streams most commonly used as input material for SRF production.

7.3 Traded forms of solid recovered fuels

Solid recovered fuels are traded in many varied sizes and shapes. The size and shape influence the handling of the fuel as well as its combustion properties. Recovered fuels can be delivered in the forms shown in Table 4. Other forms are also present on the market.

Table 4 — Examples of major traded forms of solid recovered fuels

Form name	Description
Chips	Prepared by cutting with sharp tools, particle sizes often between 5-100 mm
Crushed material Example: Fluff	Prepared by crushing or shredding
Densified fuels Example: Pellets Briquettes	Prepared by mechanical compression
Bales Example: Big square bales Round bales (cylindrical)	Compressed or loose material bound to squares or cylinders, indicative size 1-2 m ³ Some bales are wrapped in plastic to decrease odour problems and to increase fire safety during transport and storage.
Fibre cake	Prepared from fibrous waste by dewatering
Granulate	Usually in the size of 1-10 mm, produced either through agglomeration of powder or by grinding material down to appropriate size

7.4 Properties obligatory to specify

The following properties shall be specified according to the specification template in [Annex A](#):

Class code	shall be filled in as described in Clause 6 . Actual values on the fuel properties included in the classification system shall be filled in as well. These are net calorific value, chlorine and mercury content
Origin	of the input waste used for preparation of the SRF shall be specified. It can be done either by text or by the three-digit codes according to 7.2 .
Traded form	of the SRF shall be specified. Examples of forms are pellets, bales, briquettes, chips, flakes, fluff and powder. For reference see 7.3 . Other forms can be used and shall then be specified separately
Particle diameter (d_x)	in the fuel shall be specified by sieving or equivalent techniques, and be expressed as d_x , where d is the particle size on the distribution curve where x % in mass passes. The value could either be stated as a fixed value or as a P-designated value (see Annex A and example in Annex F)
Ash content (A)	shall be specified on dry bases according to ISO 21656
Moisture content (M)	shall be specified as received according to ISO 21660-3
Net calorific value (NCV)	shall be specified both as received and on dry bases according to ISO 21654. The values shall be expressed as an arithmetic mean on both dry and as received basis.
Chemical properties	the chlorine content shall be specified based on dry basis and given as an arithmetic mean, the content of each heavy metal separately shall be specified as median on dry basis. The heavy metals are antimony, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, thallium, tin and vanadium.

7.5 Properties non-obligatory to specify

Other properties than the ones specified in [Annex A](#) can be of interest for the end user and can be used as an effective communication tool with producers, power plant builders and equipment manufacturers. The producers and the users should agree upon which properties (if any) that are relevant. Some of the more common properties that can be of interest are:

Biomass content	the fraction of biomass can be expressed by weight, by energy content or by carbon content. The biomass content in percent by carbon content is necessary to calculate the emission of biomass or fossil carbon dioxide per unit of SRF. The determination is recommended to be done according to ISO 21644 ^[3] .
Composition	is the percentage in mass of main fractions of wood, paper, plastics, rubber, textiles etc. The number of fractions to be specified is agreed between the producer and the user. The basis (dry or wet) should be specified.
Fuel preparation	depends on the input waste and the field of application. Since the preparation effects the properties of the fuel it can be of interest to describe. The description also gives valuable information to the end-user that could be used when planning how to store, transport and handle the fuel. Common fuel preparation techniques are given in Annex B . Annex B can also be used as a template.
Physical properties	example of other parameters that can be used for specification of the SRF are: — particle size distribution (including defining fines and coarse material) — bulk density (ρ) and the result to be expressed as an arithmetic mean on as received basis, — volatile matter (VM), where it is recommended to use ISO 22167^[4] and the result expressed as median in percent in mass on dry basis, — bridging behaviour, — self-heating properties, — the ash melting behaviour.
Chemical properties	such as major and trace elements in the fuel can be specified. — carbon (C), hydrogen (H), nitrogen (N) and sulphur (S) is recommended to be determined according to ISO 21663^[5] and expressed as an arithmetic mean on dry basis, — halogens (F, Br, I) expressed as median on dry basis, — trace elements expressed as median on dry basis.

There are several other properties that can be used for defining SRF. Such properties, like dusting, odour, ignition temperature, can be added to the list of informative parameters in the template.

8 Compliance rules

8.1 Compliance rules for classification

8.1.1 General compliance rules

The compliance rules for classification are illustrated by examples in [Annex E](#).

For each characteristic specified in the classification system, the compliance of a particular SRF shall be established by demonstration that the results of the measured properties conform to the limit values defined for that class. The compliance is based on

- a defined maximum lot size of 1 500 tonnes
- a minimum number of increments as well as a minimum size of those increments to form a composite sample
- a minimum number of measurements to be performed.

The demonstration shall be based on the measurements of 10 lots. This can either be in the form of lot 1-10, 11-20, etc or in the form of 1-10, 2-11, etc. The maximum weight of a lot for classification shall be no more than 1 500 tonnes. The compliance shall be documented in a quality monitoring system.

For each lot, at least one measurement of each characteristic shall be performed. The sampling procedure is illustrated in [Figure 2](#). For sampling, ISO 21645 shall be applied. A sub-sample of the laboratory sample (retained sample) shall be kept for a period of minimum 6 months in case of a cross check is needed. In order to reduce the quantity for the storage of the retained sample a particle size reduction and sample division can be performed. The retained sample should be taken into consideration when determining the minimum laboratory sample size according to ISO 21645.

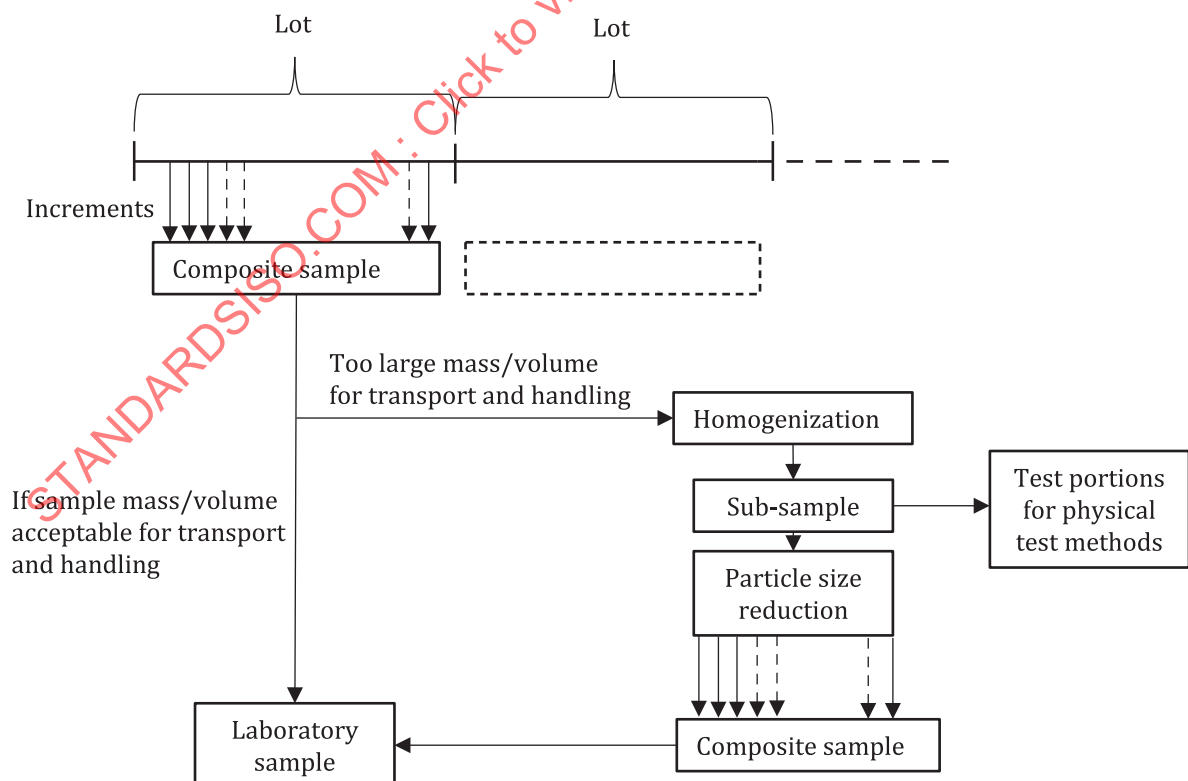


Figure 2 — Illustration of sampling and sample procedure. Number and size of increments depend on the heterogeneity of the SRF and on required accuracy and precision

The comparison for NCV and Cl with the limit values of the classes is made by taking the arithmetic mean of 10 measurements into account.

The class code for Hg is established using median and 80th percentile based on data sets of 10 consecutive measurements. For process control reasons, it is recommended to calculate the median and the 80th-percentile value after the measurement of every lot (e.g. for data sets No. 1 to No. 10 / No. 2 to No. 11 / etc.) and to consider the brief time variation of the analytical results.

EXAMPLE The class code of a SRF having a mean net calorific value of 19 MJ/kg (ar), a mean chlorine content of 0,5 % in mass (d) and a median mercury content of 0,016 mg/MJ (ar) with 80th percentile value of 0,05 mg/MJ (ar) is designated as:

Class code NCV 3; Cl 2; Hg 2.

For other examples, see [Annex E-F](#).

If there are significant changes in the properties of input materials or in the production process that result in a change of class code, see [8.1.2](#).

8.1.2 Start-up or considerable changes in the production

After the start of the production of SRF or after a notable change in the production, the minimum of 10 measurement results can be obtained on one or several lots as defined above. When several composite samples are taken on the same lot they shall be taken independently.

Within the characterisation period it is recommended to use as a prediction method for virgin producers the 50 % rule for Hg classification. This prediction method is working according to the principle of a conservative classification (indirect safety margin).

NOTE The 50 % rule means that classification is determined by comparing the measurement results to 50 % of the class limits (median and/or 80-percentile). More details are available in CEN/TR 15508^[2].

8.1.3 Exemptions

If the producer can show that due to the nature of the input material used for the production of SRF, Hg is always in class 1 when the 50 % rule is applied according to [Clause 6](#), then Hg will not have to be analysed in every lot. (See [8.1.2](#) for description of the 50 % rule). This exemption is applicable after the start-up of the production of SRF when at least 10 measurement results are available. All 10 measurement results must be within the class 1 limit. In this case the validity shall be checked at least once every year.

This exemption will only be accepted as long as there are no significant changes in the properties of input materials that would result in a change of class for Hg.

For large streams of solid recovered fuels not every lot has to be measured. The maximum lot size remains with 1 500 tonnes and at minimum two lots per month have to be measured. In any case, for each lot a laboratory sample must be taken and shall be kept for a period of minimum 12 months.

8.2 Compliance rules for specification

8.2.1 General compliance rules

For the chemical properties according to [7.4](#) and [Annex A](#), the compliance rules specified for the classification apply.

If the producer and user have agreed upon additional properties to be specified (see [7.5](#)), they can also agree upon lot size up to a maximum of 1 500 tonnes and the number of measurements to consider for

compliance. These elements should be stated in the specification. In case these elements are not defined in the SRF specification, then the lot size and compliance rules specified for the classification apply.

8.2.2 Exemptions

If the producer can show that due to the nature of the input material used for the production, one or more normative properties according to [Annex A](#) are not relevant, then the user and the producer can agree upon reducing the samples that should be analysed. In this case the validity shall be checked at least once every year. The relevance can be evaluated considering the technological/environmental limitations of the designated plants using SRF for energy conversion or the composition and properties of the waste input streams the SRF is produced from.

This exemption is applicable when at least 10 measurement results are available.

This exemption will only be accepted if there are no significant changes in the properties of input materials. The validity shall be checked at least once every year. In any case, for each lot a laboratory sample shall be taken and shall be kept for a period of minimum 12 months.

9 Requirements and declaration of conformity

In conformity with this document, SRF shall comply with the following requirements:

- a) SRF shall be classified according to the system in [Clause 6](#);
- b) SRF properties shall be specified according to [Clause 7](#);
- c) SRF shall meet quality requirements according to given compliance rules in [Clause 8](#).

The producer/supplier of solid recovered fuel shall give a declaration of conformity to this document. The record shall be kept available for inspection. A model template for the declaration is given in [Annex C](#).

NOTE General criteria for a supplier's declaration is given in ISO/IEC 17050-1:2010^[6] and ISO/IEC 17050-2:2004^[7].

Annex A (normative)

Template for the specification of solid recovered fuels

Table A.1 — Template for the specification of solid recovered fuels

Class code and origin					
Class code:					
Origin: According to 7.2 and Table 1					
Physical parameters					
Traded Form:					
Particle size d_{95} (mm)					
Main fraction ^b (minimum 95 % in mass), mm					
☐ P8 $d_{95} \leq 8$ mm	☐ P12 $d_{95} \leq 12$ mm	☐ P25 $d_{95} \leq 25$ mm	☐ P50 $d_{95} \leq 50$ mm		
☐ P90 $d_{95} \leq 90$ mm	☐ P140 $d_{95} \leq 140$ mm	☐ P200 $d_{95} \leq 200$ mm	☐ P300 $d_{95} \leq 300$ mm		
☐ P500 $d_{95} \leq 500$ mm	☐ P1000 $d_{95} \leq 1000$ mm	☐ P1500+ $d_{95} > 1500$ mm			
		Typical value (mean)	Limit value		
			Min	Max	80 th per- centile
Ash Content, A ISO 21656		(% in mass (d))			
Moisture, M CEN/TS 15414-1, ^[8] CEN/TS 15414-2, ^[9] ISO 21660-3		(% in mass (ar))			
Net calorific value, NCV ISO 21654		(MJ/kg (ar))			
		(MJ/kg (d))			
Chemical properties					
	Standard method used		Typical value (mean)	Limit value	
				Max	80 th percentile
Chlorine, Cl		(% in mass (d))			
			Typical value (median)	Limit value	
				Max	80 th percentile
Antimony, Sb		(mg/kg (d))			
Arsenic, As		(mg/kg (d))			
Cadmium, Cd		(mg/kg (d))			
Chromium, Cr		(mg/kg (d))			
Cobalt, Co		(mg/kg (d))			
Copper, Cu		(mg/kg (d))			
Lead, Pb		(mg/kg (d))			
Manganese, Mn		(mg/kg (d))			
Mercury, Hg		(mg/MJ (d))			
Nickel, Ni		(mg/kg (d))			
Thallium, Tl		(mg/kg (d))			
Tin, Sn		(mg/kg (d))			

Table A.1 (continued)

Class code and origin			
Class code:			
Origin: According to 7.2 and Table 1			
Physical parameters			
Traded Form:			
Particle size d_{95} (mm)			
Main fraction ^b (minimum 95 % in mass), mm			
☐ P8 $d_{95} \leq 8$ mm	☐ P12 $d_{95} \leq 12$ mm	☐ P25 $d_{95} \leq 25$ mm	☐ P50 $d_{95} \leq 50$ mm
☐ P90 $d_{95} \leq 90$ mm	☐ P140 $d_{95} \leq 140$ mm	☐ P200 $d_{95} \leq 200$ mm	☐ P300 $d_{95} \leq 300$ mm
☐ P500 $d_{95} \leq 500$ mm	☐ P1000 $d_{95} \leq 1000$ mm	☐ P1500+ $d_{95} > 1500$ mm	
Vanadium, V		(mg/kg (d))	

White fields are normative while blue shaded fields are informative.

An electronic version of this form is available at https://standards.iso.org/iso/21640/ed-1/en/Annex_A.pdf.

The user is permitted to use the form in its original format without any modifications for the purposes specified in this document.

Annex B (informative)

Fuel preparation

Table B.1 — Fuel preparation

Preparation level			
1	2	3	
Untreated ☐			
Sorting ☐	Manual sorting ☐ Mechanical sorting ☐ Other (specify) ☐	Picking crane ☐ Bucket screen ☐ Other (specify) ☐ 	
Biological treatment ☐	Aerobic treatment ☐ Anaerobic treatment ☐ Other (specify) ☐		
Crushing, grinding, shredding ☐	Shredder ☐ Crusher ☐ Mill ☐ Other (specify) ☐	Single rotor shredder ☐ Two shaft shredder ☐ Four shaft shredder ☐ Other (specify) ☐ Screw crusher ☐ Jaw crusher ☐ Other (specify) ☐ Ball mill ☐ Gravity fed hammer mill ☐ Horizontal fed hammer mill ☐ Other (specify) ☐	
Separation ☐	Magnetic material separation ☐	Magnetic drum separator ☐ Magnetic drive pulley ☐ Suspended cross belt separator ☐ In line magnetic separator ☐ Other (specify) ☐	

Table B.1 (continued)

Preparation level		
1	2	3
Untreated ☐		
	Non-magnetic material separation ☐	Eddy current separator ☐
		Cascade ☐
		Other (specify) ☐
	Gravity separation ☐	Wind separation, air classifier, wind shifter ☐
		Ballistic separation ☐
		Wet separation ☐
		Other (specify) ☐
	Optical separation ☐	
	Other (specify) ☐	
Screening ☐	Rotating (drum) screen ☐	
	Oscillating screen ☐	
	Reciprocating screen ☐	
	Screen disc ☐	
	Star screener ☐	
	Other (specify) ☐	
Washing ☐		
Drying, cooling ☐	Drying ☐	
	Cooling ☐	
Homogenisation, compacting ☐	Mixing ☐	
	Blending ☐	
	Compressing ☐	Pelletizing ☐
		Bracketing ☐
		Baling ☐
		Other (specify) ☐
	Other (specify) ☐	
Dust prevention ☐		

The user is permitted to use the form in its original format without any modifications for the purposes specified in this document.

Annex C
(informative)

Template for declaration of conformity

Declaration No _____

Supplier _____

Address _____

Solid recovered fuel identification _____

The Solid recovered fuel described above is in conformity with

Solid recovered fuels – Specifications and classes

(this document) ISO 21640

The SRF described above is also in conformity with

_____ ☐ Yes ☐ No

_____ ☐ Yes ☐ No

_____ ☐ Yes ☐ No

The following quality management system (QMS) has been applied during the corresponding production period

Additional information

Signed on behalf of (name and address of supplier)

Signature: _____

Position/function: _____ Date of issue: _____

An electronic version of this form is available at https://standards.iso.org/iso/21640/ed-1/en/Annex_C.pdf.

The user is permitted to use the form in its original format without any modifications for the purposes specified in this document.

Every declaration should be identified for easy reference.

NOTE 1 The SRF is unequivocally described so that the declaration can be related to the product in question.

NOTE 2 The documents are listed with their document identification, title and date of issue.

NOTE 3 Additional information can be supplied so that it is possible to relate the declaration to the conformity results on which it is based, for example the name and address of the test laboratory or certification body involved, reference to a conformance test report, reference to the management system involved (i.e. self-assessed or certified/registered) or reference to the laboratory accreditation document.

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Annex D (informative)

Calculation of standard deviation, median and 80th percentile

D.1 Standard deviation

The standard deviation is a measure of the dispersion of a set of values from its mean and is calculated as the square root of variance.

EXAMPLE D.1

Table D.1 Data set with 10 measurements of NCV

NCV MJ/kg (ar)									
8,5	9,9	9,9	10,0	10,1	10,5	10,9	11,1	11,5	12,0

The arithmetic mean value is 10,4 MJ/kg (ar).

$$((8,5 + 9,9 + 9,9 + 10,0 + 10,1 + 10,5 + 10,9 + 11,1 + 11,5 + 12,0) : 10 = 10,4)$$

The standard deviation s is 0,94 MJ/kg (ar) ($s = \sqrt{8,88 : 10} = 0,94$).

$$((8,5-10,4)^2 + (9,9-10,4)^2 + (9,9-10,4)^2 + (10,0-10,4)^2 + (10,1-10,4)^2 + (10,5-10,4)^2 + (10,9-10,4)^2 + (11,1-10,4)^2 + (11,5-10,4)^2 + (12,0-10,4)^2 = 8,88)$$

D.2 Median

For the classification always exactly 10 measurements are needed. With an even number of measurements, the median value corresponds to the arithmetic mean of the middle two values of the by size ordered data set.

EXAMPLE D.2

Table D.2 Data set with 10 measurements of Hg

Hg (mg/MJ (ar))									
0,018	0,020	0,020	0,020	0,023	0,025	0,027	0,030	0,032	0,051

$$\text{Median} = (0,023 + 0,025) : 2 = 0,024 \text{ mg/MJ ar}$$

The calculated median value (0,024 mg/MJ (ar)) is rounded down at 0,02 mg/MJ (ar).

NOTE In case of a median value of 0,025 mg/MJ, it is rounded up at 0,03 mg/MJ (ar).

D.3 80th percentile

To calculate the 80th percentile the number of the measurements has to be multiplied by 0,8. If this product is not integer, the succeeding integral number has to be determined. The corresponding value to this number is the 80th percentile. If the product is integer, the arithmetic mean of the corresponding value and the succeeding value is the 80th percentile.

EXAMPLE D.3

The data set consists of 10 measurements. The number of measurements multiplied by 0,8 results in an integer value ($10 \times 0,8 = 8$). The arithmetic mean of the corresponding value (0,030 mg/MJ ar) and the succeeding value (0,032 mg/MJ ar) is the 80th percentile (0,031 mg/MJ ar).

Table D.3 Data set with 10 measurements of Hg

Hg (mg/MJ (ar))									
0,018	0,020	0,020	0,020	0,023	0,025	0,027	0,030	0,032	0,051

$$80^{\text{th}} \text{ percentile} = (0,030 + 0,032) : 2 = 0,031 \text{ mg/MJ (ar)}$$

The calculated 80th percentile (0,031 mg/MJ ar) is rounded down at 0,03 mg/MJ ar.

Annex E (informative)

Examples of establishing of compliance with SRF classification

E.1 General

The examples illustrate procedures for different SRF production plants with

(Example E.1) annual production of 30 000 tonnes, continuous operation.

(Example E.2) annual production of 100 000 tonnes, continuous operation without analysing every lot.

(Example E.3) start of new production of 5 000 tonnes during 5 months of production.

E.2 Compliance SRF classification for a 30 000 tonnes annual production plant

EXAMPLE E.1 Production volume 30 000 tonnes per year (Figure E.1)

SRF is produced in an existing production unit. The same type of SRF is produced for the whole period. The considered production period is uninterrupted. The production volume is 30 000 tonnes per year. The plant is in operation 12 hours per day, 5 days a week for 11 months a year.

The chosen lot size is 1 500 tonnes. Since every lot shall be measured this means that 20 measurements (30 000:1 500) needs to be taken yearly and evenly distributed during the time of operation (See Figure E.1). Since each composite sample shall consist of at least 24 increments it means in total 480 increments (20 x 24).

The plant's operating schedule corresponds to 48 weeks or 240 days of planned operation a year. It means that 2 increments (480:240) needs to be taken daily, i.e. 10 increments per week.

The company chose to use the consecutive measurements for calculating the arithmetic mean of NCV and CI as well as of median and 80th percentile of Hg.

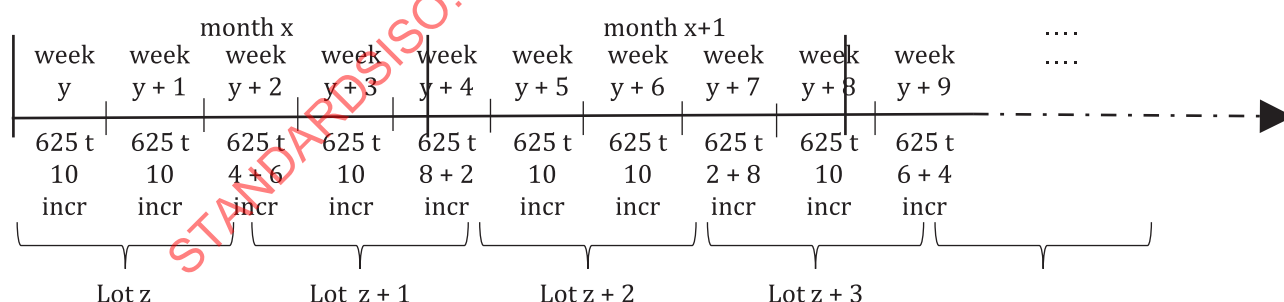


Figure E.1 — Lot distribution in Example 1

Table E.1 Results from measurements of the 10 last lots regarding the parameters used for classification

	1	2	3	4	5	6	7	8	9	10
NCV MJ/kg (ar)	8,5	10,5	10,0	9,9	11,1	11,5	12,0	10,1	9,9	10,9
CI % in mass (d)	0,85	0,96	0,66	1,21	0,95	0,87	0,85	1,02	0,97	1,11

Hg mg/MJ (ar)	0,023	0,018	0,051	0,030	0,032	0,020	0,025	0,020	0,027	0,020
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Calculation of the classification parameters shown in Table E.1:

- NCV: The arithmetic mean value is 10,4 MJ/kg (ar).
 $((8,5 + 10,5 + 10,0 + 9,9 + 11,1 + 11,5 + 12,0 + 10,1 + 9,9 + 10,9) : 10 = 10,4)$
→ **Class code NCV: 4**
- Cl: The arithmetic mean value is 0,94 % in mass (*d*).
The calculated arithmetic mean value for Cl is rounded down at 0,9 % in mass (*d*).
→ **Class code Cl: 3**
- Hg: The median value is 0,024 mg/MJ (ar) $((0,023 + 0,025) : 2 = 0,024)$
The 80th percentile is 0,31 mg/MJ (ar) $(10 \cdot 0,8 = 8; (0,030 + 0,032) : 2 = 0,031)$

Table E.2 Results from measurements of Hg arranged according to increasing order

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	2	6	8	10	1	7	9	4	5	3
Hg mg/MJ (ar)	0,018	0,020	0,020	0,020	0,023	0,025	0,027	0,030	0,032	0,051

The calculated median value for Hg (0,024 mg/MJ ar) is rounded down at 0,02 mg/MJ ar.

The calculated 80th percentile for Hg (0,031 mg/MJ ar) is rounded down at 0,03 mg/MJ ar.

→ **Class code Hg: 1**

Table E.3 Calculated parameters used for classification

	Arithmetic Mean value	Median value	80 th percentile
NCV MJ/kg (ar)	10	-	-
Cl % in mass (<i>d</i>)	0,9	-	-
Hg mg/MJ (ar)	-	0,02	0,03

The calculated parameters shown in Table E.3 results in the following class code:

→ **Class Code: NCV 4; Cl 3; Hg 1**