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Solid recovered fuels — Specifications and classes

National foreword

This British Standard is the UK implementation of EN 15359:2011. It supersedes DD CEN/TS 15359:2006 which is withdrawn.

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

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

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Combustibles solides de récupération - Spécification et classes

Feste Sekundärbrennstoffe - Spezifikationen und Klassen

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Foreword

This document (EN 15359:2011) has been prepared by Technical Committee CEN/TC 343 “Solid recovered fuels”, the secretariat of which is held by SFS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2012, and conflicting national standards shall be withdrawn at the latest by May 2012.

This document supersedes CEN/TS 15359:2006.

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

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

This document differs from CEN/TS 15359:2006 mainly as follows:

a) it has been clarified that SRF still is a waste destined to be incinerated in combustion and co-combustion plants covered by the Directive 2000/76/EC on waste incineration (WID);

b) in the scope NOTE 1 concerning solid biofuels has been modified;

c) the references to community legislation have been updated;

d) the terminology has been brought into line with EN 15357;

e) the classification system in Clause 7 has been furnished with clarifying examples and notes – so also the compliance rules in Clause 8;

f) the period of which a laboratory sample shall be kept has been expressed more precisely;

g) a way to calculate the emission factor has been added in 9.3 (Properties non-obligatory to specify);

h) a new Annex D (informative) has been added in which is demonstrated how to calculate the statistical means for different production volumes;

i) the whole document has been editorially revised.

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

Introduction

The objective of this document is to provide unambiguous and clear classification and specification principles for solid recovered fuels (SRF). The document aims at serving as a tool to enable efficient trading of SRF, promoting their acceptability on the fuel market and increasing the public trust. The document will facilitate a good understanding between seller and buyer, facilitate purchase, transborder movements, use and supervision as well as a good communication with equipment manufacturers. It will also facilitate authority permission procedures and ease the reporting on the use of fuels from renewable energy sources and on other 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 great 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 purpose of producing a solid recovered fuel is to use it for energy generation at the highest possible energy efficiency. SRF can according to Article 6 of the Waste Framework Directive (2008/98/EC) cease to be waste at Community or national level if certain criteria are fulfilled. Until such legal decisions are taken SFR can be used in plants covered by the Directive 2000/76/EC.

This document describes the compliance rules which SRF has to meet to be classified according to the classification system. It also describes how the supplier can establish a declaration of conformity to the different EN standards for SRF.

Figure 1 illustrates a simplified flow chain for SRF, from input of waste to end use of SRF. This document has an interface to all the stages in the chain, but SRF classification and specification are applicable at the point of delivery as shown in the figure. Requirements for how the input waste is collected and how to use the fuel are not part of this document.

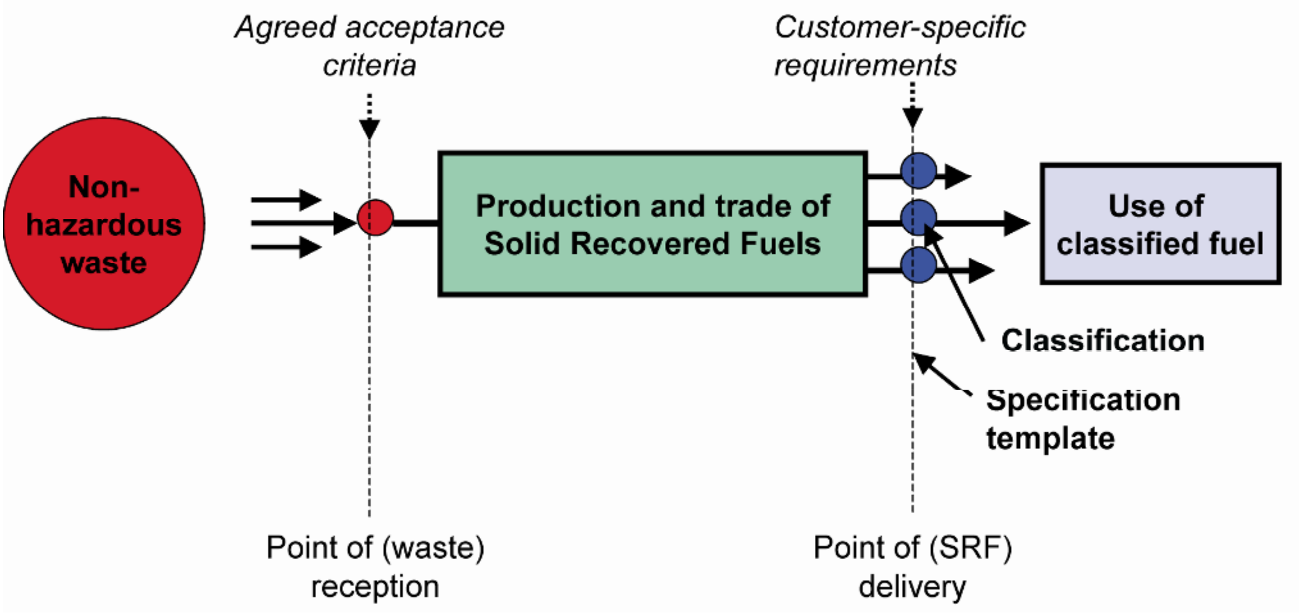

Figure 1 — Solid recovered fuels chain — The EN Standard on specifications and classes is applicable at the point of delivery

1 Scope

This document specifies a classification system for solid recovered fuels (SRF) and a template for the specification of their properties.

SRF are produced from non-hazardous waste.

NOTE 1 Waste referred to in article 2(2)(a), points (i)-(v) of the Waste Incineration Directive (2000/76/EC) is not included in the scope of this document. This is covered by CEN/TC 335 "Solid biofuels". Waste wood from demolition of buildings and civil engineering installations is, however, included in the scope.

NOTE 2 Untreated municipal solid waste is not included in the scope of this document.

2 Normative references

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

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

EN 15400, *Solid recovered fuels — Determination of calorific value*

EN 15403, *Solid recovered fuels — Determination of ash content*

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

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)*

CEN/TS 15414-1:2010, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 1: Determination of total moisture by a reference method*

CEN/TS 15414-2:2010, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 2: Determination of total moisture by a simplified method*

EN 15414-3, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 3: Moisture in general analysis sample*

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

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

3 Terms and definitions

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

NOTE The terms and definitions 3.1 to 3.16 are identical with the ones given in EN 15357.

3.1
classification
grouping of solid recovered fuels into classes

NOTE The classes are defined by boundary values for chosen fuel characteristics to be used for trading as well as for information of permitting authorities and other interested parties.

3.2
combined sample
sample consisting of all the increments taken from a lot

NOTE The increments may be reduced by division before being added to the combined sample.

3.3
component
part of portion of a solid recovered fuel that can be separated by hand or by using simple physical means

3.4
composition
break down of a solid recovered fuel by types of components e.g. wood, paper, board, textiles, plastics, rubber

3.5
delivery agreement
contract for fuel trade, which specifies e.g. origin and source, quality and quantity of the fuel, as well as delivery terms

3.6
increment
portion of fuel extracted in a single operation of the sampling device

[ISO 13909:2001]

3.7
laboratory sample
part of the sample sent to or received by the laboratory

NOTE 1 When the laboratory sample is further prepared (reduced) by subdividing, mixing, grinding, or by combinations of these operations, the result is the test sample. When no preparation of the laboratory sample is required, the laboratory sample is the test sample. A test portion is removed from the test sample for the performance of the test or for analysis.

NOTE 2 The laboratory sample is the final sample from the point of view of sample collection but it is the initial sample from the point of view of the laboratory.

NOTE 3 Several laboratory samples may be prepared and sent to different laboratories or to the same laboratory for different purposes. When sent to the same laboratory, the set is generally considered as a single laboratory sample and is documented as a single sample.

3.8
lot
defined quantity of fuel for which the quality is to be determined

NOTE 1 See also sub-lot.

[ISO 13909:2001]

3.9
net calorific value
calculated value of the energy of combustion for unit of mass of a fuel burned in oxygen in calorimetric bomb under such conditions that all water of the reaction products remains as water vapour at 0,1 MPa

NOTE 1 The net caloric value can be determined at constant pressure or at constant volume. The net calorific value at constant pressure is however the generally used.

NOTE 2 See also calorific value and gross calorific value.

3.10
point of delivery
location specified in the delivery agreement, at which the proprietary rights of and responsibility for a fuel are transferred from one organization or unit to an other

3.11
producer
organization or unit responsible for the production of the fuel

NOTE The producer can also be the supplier of the fuel.

3.12
solid recovered fuel
solid fuel prepared from non-hazardous waste to be utilised for energy recovery in incineration or co-incineration plants and meeting the classification and specification requirements laid down in this European Standard

NOTE “Prepared” here means processed, homogenised and up-graded to a quality that can be traded amongst producers and users.

3.13
specification
document stating requirements

[EN ISO 9000:2005]

3.14
specification of solid recovered fuels
specification for the properties characterising a solid recovered fuel

NOTE A template for such specification is given in Annex A.

3.15
sub-lot
part of a lot for which a test result is required

3.16
sub-sample
portion of a sample

NOTE 1 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 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.

3.17
supplier
organization or unit that provides the fuel

4 Symbols and abbreviations

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

Item	Symbol	Abbreviation
net calorific value	$q_{p,net}$	NCV
gross calorific value	$q_{V,gr}$	GCV
as received		ar
dry basis		d
particle diameter		*d*

5 Principles

The classification system is based on three important characteristics, referred to 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.

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

The classification itself is not enough for an intending user. A user has to have a more detailed description of the fuel. Relevant fuel properties are thus to be further specified. Some of the fuel properties are 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 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 7;

b) SRF shall meet quality requirements according to given compliance rules in Clause 8;

c) SRF properties shall be specified according to Clause 9.

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 EN ISO/IEC 17050-1:2010 and EN ISO/IEC 17050-2:2004.

7 Classification

The classification system (Table 1) for SRF is based on limit values for three important fuel characteristics. These are:

a) the mean value for net calorific value (ar);

b) the mean value for chlorine content (d);

c) the median and 80th percentile values for mercury content (ar).

Each characteristic is divided into 5 classes. The SRF shall be assigned a class number from 1 to 5 for each characteristic. A combination of the class numbers makes up the class code (see example below). The characteristics are of equal importance and thus no single class number determines the code.

The class code shall be included in the specification as described in Clause 9.

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

— net calorific value (NCV) mean (arithmetic);

— chlorine content (Cl) mean (arithmetic);

— mercury content (Hg) median and 80th percentile.

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

EXAMPLE A SRF with a median value of 0,03 and a 80th percentile value of 0,07 belongs to Hg class 3 (according to Table 1).

For the determination of NCV EN 15400, for Cl EN 15408 and for Hg EN 15411 shall be used.

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

NOTE 2 For details on statistics see CEN/TR 15508 [5].

NOTE 3 The averages and percentiles are determined on the quantity of SRF as specified in Clause 8.

NOTE 4 The classes have been determined as a tool for identifying and pre-selecting SRF. However, 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 5 Not all kinds of SRF are suited for all types of installation (see CEN/TR 15508) [5]. For example, if 100 % SRF is used as fuel and an emission limit for Hg is defined at 0,05 mg/m^3, for cement and lime kilns as well as for power plants, Class Hg 1 fuels would fit to all types of these. Class Hg 5 fuels could only be used in these processes if this class of fuel is less than 100 % of the fuel mix. For other classes the specific transfer factor of a given process and the proportion of SRF will determine which classes can be used without improvement of the transfer conditions. Examples of transfer factors for existing processes are given in CEN/TR 15508.

NOTE 6 SRF should not be used as a fuel if there is less thermal energy produced from the combustion of the SRF and available for the process of the installation, than the energy used by the combustion of the SRF (thus not available for the process). This can, for example, prevent the use of class NCV 5 in installations requiring a higher minimum NCV for energy recovery.

Table 1 — Classification system 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
Classification characteristic	**Statistical measure**	**Unit**	**Classes**				
			1	**2**	**3**	**4**	**5**
Chlorine (Cl)	Mean	% (d)	≤ 0,2	≤ 0,6	≤ 1,0	≤ 1,5	≤ 3
Classification characteristic	**Statistical measure**	**Unit**	**Classes**				
			1	**2**	**3**	**4**	**5**
Mercury (Hg)	Median	mg/MJ (ar)	≤ 0,02	≤ 0,03	≤ 0,08	≤ 0,15	≤ 0,50
	80th percentile	mg/MJ (ar)	≤ 0,04	≤ 0,06	≤ 0,16	≤ 0,30	≤ 1,00

Example of classification:

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

Class code NCV 3; Cl 2; Hg 2.

8 Compliance rules

8.1 Compliance rules for classification

The compliance rules for classification are illustrated by examples in Annex D.

For a considered 12 months period, for each characteristic specified in the classification system, the compliance of a particular SRF shall be established by demonstration that the measured properties conform to the limit values defined for that class. This shall be performed at a period in which a quality management system (QMS) is applied. The maximum weight of a lot for classification shall be no more than 1 500 tonnes. When the 12 month production is less than 15 000 tonnes the lot size for classification shall be one tenth of the amount produced in a 12 months rolling period.

If there are significant changes in the properties of input materials or in the production process conditions, the production shall be considered to be interrupted. Significant here means such a change that would result in a change of class code.

NOTE 1 If the classification cannot be based on a 12 month period of actual production, an estimation of the planned production of the missing month should be included in the rolling 12 month period.

NOTE 2 A quality management system is meant as any systematic procedure used for complying with this European Standard.

For each lot, at least one measurement of each characteristic shall be performed. An additional laboratory sample shall be taken in case of a cross check is needed. The laboratory sample shall be kept for a period of minimum 12 months. The sampling and sample procedure are illustrated in Figure 2. For sampling and sample reduction EN 15442 shall be applied.

The comparison for NCV and CI with the limit values of the classes is made by taking the 95 % confidence interval of the arithmetic mean of 10 measurements into account. For the calculation of the lower and the upper limit of the 95 % confidence interval of the arithmetic mean the following equation shall be used:

$$X = \overline{X} \pm 1{,}96 \cdot \frac{s}{\sqrt{n}}$$

where

X is the lower/upper limit of the 95 % confidence interval of the arithmetic mean;

$\overline{X}$ is the arithmetic mean (based on all measurements);

$1{,}96$ is the functional characteristic of the normal distribution (for the 95 % confidence interval);

s is the standard deviation (based on all measurements);

n is the number of measurements (here n = 10).

Decisive for the categorisation of the characteristic NCV is the calculated lower limit of the 95 % confidence interval of the arithmetic mean and for CI the corresponding upper limit.

The class code for Hg is established using median and 80^{th} percentile based on data sets of 10 consecutive measurements.

If, at the end of the 12 month period, an incomplete data set exists (with less than 10 data), these data shall be used in the following 12 month period and be completed with the consecutive measurements of that period to a full data set of 10 measurements. In the case that for one characteristic to be classified several analyses of a 12 month period lead to different classification results, always the highest class has to be used for the determination of the class of the SRF (see Example 2 in D.2).

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

For process control reasons it is recommended to calculate the median and the 80 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 short time variation of the analytical results.

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 3 If production time is less than 12 months it can be considered and treated as an initial phase of the production.

NOTE 4 The 50 % rule means that classification is determined by comparing the measurement results to 50 % of the class limits (median and/or 80-percentile). For more details see CEN/TR 15508 [5].

8.2 Compliance rules for specification

The SRF specification to be agreed upon by the supplier and the user may define the lot size up to a maximum of 1 500 tonnes as well as by the compliance rules. In case these elements are not defined in the SRF specification, then the lot size and compliance rules specified for the classification apply.

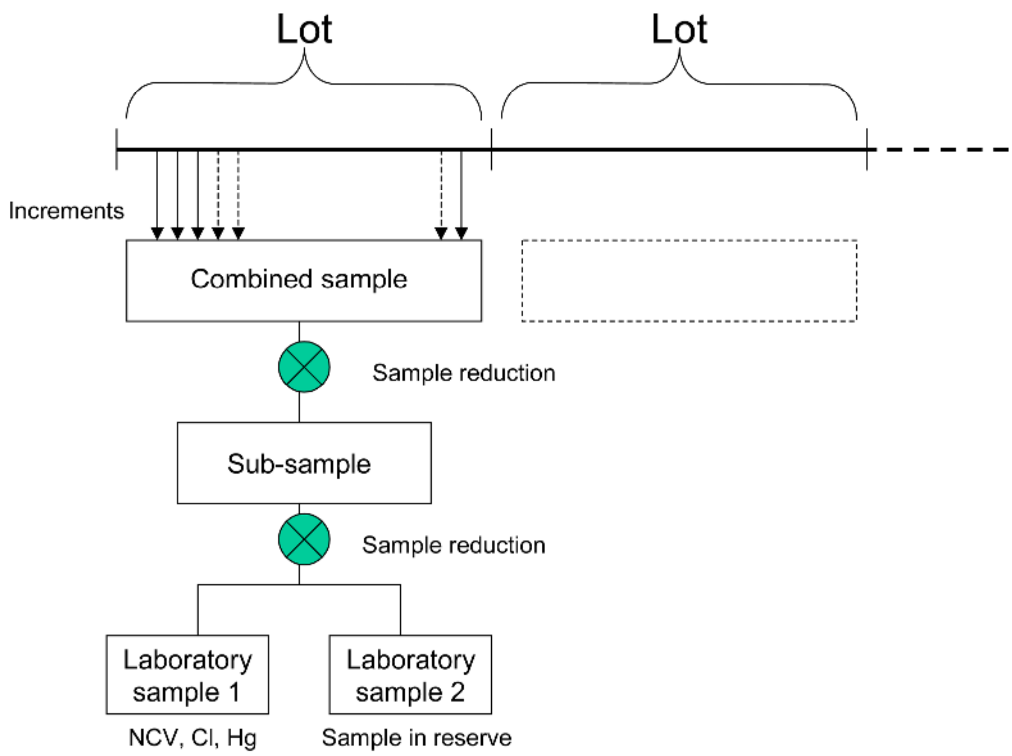

Figure 2 — Illustration of sampling and sample procedure. Number and size of increments depend on the heterogenity of the SRF and on required accuracy and precision (see EN 15442)

9 Specifications

9.1 General

The SRF shall be specified according to the template in Annex A. The template is divided in two parts: Part 1 consists of properties that are obligatory to specify and Part 2 of properties that are voluntary to specify. The list of properties in Part 2 may be altered (new properties added and existing removed).

For specification of the properties in Part 1 determination shall be made according to CEN test methods (Technical Specifications or European Standards). For the properties in Part 2 CEN test methods is recommended but other relevant methods may be used. If other methods are used it shall be stated in the (fuel) specification.

9.2 Properties obligatory to specify

The following properties shall be specified according to the specification template in Annex A, Part 1:

Class code shall be filled in as described in Clause 7. 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 four or six digit codes according to the European Waste List (EWC) [4]

Particle form of the SRF shall be specified. Examples of forms are pellets, bales, briquettes, chips, flakes, fluff and powder. Other forms may be used and shall then be specified separately

Particle size in the fuel shall be specified by sieving or equivalent techniques, and be expressed as *dx*, where *d* is the particle size on the distribution curve where x % passes according to EN 15415-1

Ash content shall be specified on dry bases according to EN 15403

Moisture content shall be specified as received according to CEN/TS 15414-1, CEN/TS 15414-2 and EN 15414-3

Net calorific value shall be specified both as received and on dry bases according to EN 15400

Chemical properties

— the chlorine content shall be specified based on dry basis according to EN 15408

— the content of each heavy metal separately as well as the sum thereof as mentioned in Waste Incineration Directive [2] shall be specified on dry basis according to EN 15411. The heavy metals are antimony, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, thallium and vanadium. Cadmium, mercury and thallium are not included in the sum

9.3 Properties non-obligatory to specify

The properties in Annex A, Part 2 are voluntary to specify. These properties are:

Biomass content of the SRF should be specified and shall then be measured according to EN 15440. 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 in order to calculate the emission of biomass or fossil carbon dioxide per unit SRF.

NOTE 1 More information on biomass content is available in CEN/TR 14980 [6].

NOTE 2 More information on the emission factor and how to calculate it is available in Commission Decision 2007/589/EC establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of council of 18 July 2007 [12].

NOTE 3 This is not biomass as defined in the Large Combustion Plants Directive 2001/80/EC and under future Industrial Emissions Directive (IED), but rather "biomass" as applied under the greenhouse gas/energy legislation.

Composition is the weight percentage of main fractions of wood, paper, plastics, rubber, textiles etc. 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 should be described. The description also gives valuable information to the end-user 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 may be used for specification of the SRF are bulk density, volatile content, and the ash melting behaviour

Chemical properties such as major and trace elements in the fuel may be specified

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

Annex A
(normative)

Template for the specification of solid recovered fuels

Part 1

Obligatory to specify

SRF class and origin				
Class code [a]:				
Origin [b]:				
Physical parameters				
Particle form [c]:				
Particle size [d]:			**Test method [g]**	
	Unit	**Value [e]**		**Test method [g]**
		Typical	**Limit**	
Ash content	% d			
Moisture content	% ar			
Net calorific value	MJ/kg ar			
Net calorific value	MJ/kg d			
Chemical parameters				
	Unit	**Value [e]**		**Test method [g]**
		Typical	**Limit**	
Chlorine (Cl)	% d			
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/kg d			
Nickel (Ni)	mg/kg d			
Thallium (Tl)	mg/kg d			
Vanadium (V)	mg/kg d			
∑ Heavy metals [f]	mg/kg d			

[a] According to the class system as specified in Clause 7.

[b] Preferable to European Waste List (EWC), 4 or 6 digit code. For mixtures and blends a combination of codes can be used. [4]

[c] Examples of forms are pellets, bales, briquettes, flakes, chips, powder, fluff.

[d] By sieving or equivalent technique, expressed as *dx*, where d is the particle size on the distribution curve where x percent passes.

[e] The typical value is the mean value for the physical properties and the properties of the elements except for the heavy metals and trace elements, in which case the median value should be used, for SRF over an agreed or specified period of time. The limit value (maximum, minimum or 80th percentile, in case the median has been used as typical value) will be agreed upon and defined by the user and producer, and refers to a consignment.

[f] The heavy metals in the sum are Sb, As, Cr, Co, Cu, Pb, Mn, Ni and V and equals those in the Waste Incineration Directive (WID). [2]

[g] According to relevant CEN test methods (Technical Specifications or European Standards) or other relevant test methods.

Part 2

Non-obligatory to specify

SRF origin and preparation						
Fuel preparation [a]:						
Biomass content						
Biomass fraction [b]						
Composition						
Composition *Dry basis* ☐ *As received* ☐	**Wood**	**Paper**	**Plastic**	**Rubber**	**Textile**	**Other**
	%	%	%	%	%	%
	Specification of Other:					

Physical parameters				
	Unit	**Value** [c]		**Test method** [d]
		Typical	**Limit**	
Bulk density	kg/m³			
Content of volatile matter	% d			
Ash melting behaviour	°C			

Chemical parameters					
		Unit	**Value** [c]		**Test method** [d]
			Typical	**Limit**	
Aluminium, metallic		% d			
Carbon (C)		% d			
Hydrogen (H)		% d			
Nitrogen (N)		% d			
Sulphur (S)		% d			
Bromine (Br)		mg/kg d			
Fluorine (F)		mg/kg d			
PCB		mg/kg d			
Major elements	**Aluminium (Al)**	mg/kg d			
	Iron (Fe)	mg/kg d			
	Potassium (K)	mg/kg d			
	Sodium (Na)	mg/kg d			
	Silicon (Si)	mg/kg d			
	Phosphorus (P)	mg/kg d			
	Titanium (Ti)	mg/kg d			
	Magnesium (Mg)	mg/kg d			
	Calcium (Ca)	mg/kg d			
Trace elements	**Molybdenum (Mo)**	mg/kg d			
	Zinc (Zn)	mg/kg d			
	Barium (Ba)	mg/kg d			
	Beryllium (Be)	mg/kg d			
	Selenium (Se)	mg/kg d			

a According to Annex B.

b According to EN 15440. The biomass fraction can be expressed by weight, by energy content or by carbon content.

c The typical value is the mean value for the physical properties and the properties of the elements except for the heavy metals and trace elements, in which case the median value should be used, for SRF over an agreed or specified period of time. The limit value (maximum, minimum or 80th percentile, in case the median has been used as typical value) will be agreed upon and defined by the user and producer, and refers to a consignment.

d According to CEN test methods (Technical Specifications or European Standards) or other relevant test methods.

Part 2 ***(continued)***

	Others				
		Unit	Value		Test method
			Typical	Limit	

Annex B
(informative)

Fuel preparation

Preparation Level		
1	**2**	**3**
Untreated		
Sorting	Manual sorting	
	Mechanical sorting	Picking crane
		Bucket screen
Biological treatment	Aerobic treatment	
	Anaerobic treatment	
Crushing, grinding, shredding	Shredder	Single rotor shredder
		Two shaft shredder
		Four shaft shredder
	Crusher	Screw crusher
		Jaw crusher
	Mill	Ball mill
		Gravity fed hammer mill
		Horizontal fed hammer mill
Separation	Magnetic material separation	Magnetic drum separator
		Magnetic drive pulley
		Suspended cross belt separator
		In line magnetic separator
	Non-magnetic material separation	Eddy current separator
		Cascade
	Gravity separation	Wind separation, air classifier, wind shifter
		Ballistic separation
		Wet separation
	Optical separation	
Screening	Rotating (drum) screen	
	Oscillating screen	
	Reciprocating screen	
	Screen disk	
	Star screener	
Washing		
Drying, cooling	Drying	
	Cooling	
Homogenisation, compacting	Mixing	
	Blending	
	Compressing	Pelletizing
		Bricketizing
		Baling
Dust prevention		

Annex C
(informative)

Template for declaration of conformity

Declaration No ....[1)]

Supplier ....

Address ....

Solid recovered fuel identification ....[2)]

The Solid recovered fuel described above is in conformity with

Solid recovered fuels – Specifications and classes
(this Standard)

The SRF described above is also in conformity with[3)]

……………………………...	Yes	No
……………………………...	Yes	No
……………………………...	Yes	No

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

Solid recovered fuels – Quality Management System – Particular requirements for their application to the production of solid recovered fuels (EN 15358)	Yes	No
(other) ……………………………...	Yes	No

Additional information[4)]

....
....

Signed on behalf of (name and address of supplier)

Signature:

Position/function:...Date of issue:...

1) Every declaration should be identified for easy reference.

2) The SRF should be unequivocally described so that the declaration may be related to the product in question.

3) The documents should be listed with their document identification, title and date of issue.

4) Additional information may 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.

Annex D
(informative)

Examples of establishing of compliance with SRF classification

D.1 Calculation of the median and 80 percentile

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 1 A data set with 10 measurements.

Hg [mg/MJ ar]										
-	0,018	0,020	0,020	0,020	0,023	0,025	0,027	0,030	0,032	0,051

Median = (0,023 + 0,025): 2 = 0,024 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.

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 2 Calculation of the 80th percentile for a data set with 10 measurements.

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).

Hg content of SRF [mg/MJ ar]										
-	0,018	0,020	0,020	0,020	0,023	0,025	0,027	0,030	0,032	0,051

80th percentile = (0,030 + 0,032) : 2 = 0,031 mg/MJ ar

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

D.2 Compliance with SRF classification

EXAMPLE 1 Production volume 10 000 tonnes/year (Figure D.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 12 months (from April until March). The production volume is

10 000 tonnes/year. The lot size is 1 000 tonnes which corresponds to one tenth of the production during the considered 12 month period (10 000: 10 = 1 000). For each lot at least measurements of each property shall be performed so the number of data sets is at least 10. Following the EN 15442 one combined sample has to consist of at least 24 increments. For example, one increment is taken each day and the increments are collected to a combined sample for each lot.

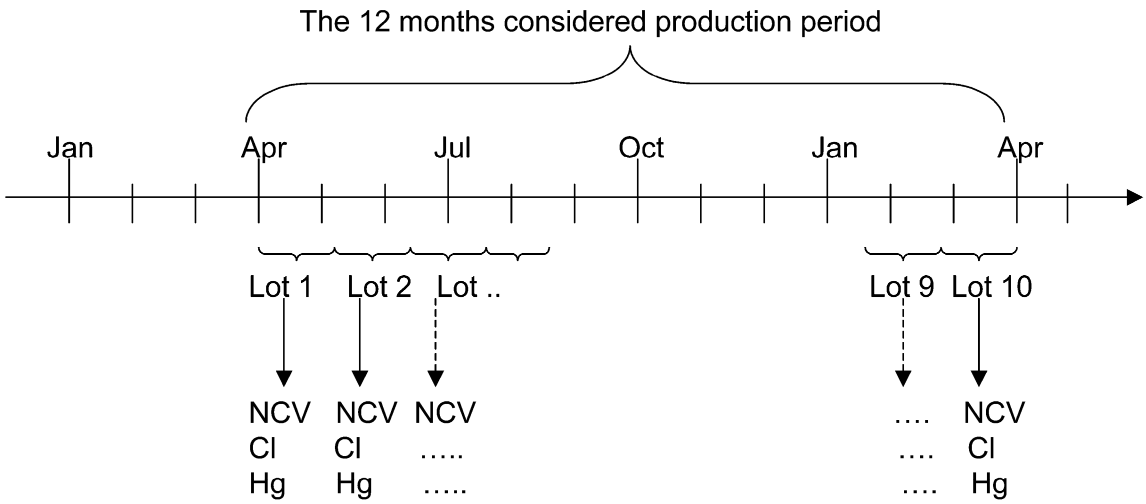

Figure D.1 — Example 1

Results from measurements of the SRF ordered by size:

	1	2	3	4	5	6	7	8	9	10
NCV MJ/kg (ar)	8,5	9,9	9,9	10,0	10,1	10,5	10,9	11,1	11,5	12,0
Cl % (d)	0,66	0,85	0,85	0,87	0,95	0,96	0,97	1,02	1,11	1,21
Hg mg/MJ (ar)	0,018	0,020	0,020	0,020	0,023	0,025	0,027	0,030	0,032	0,051

Calculation of the classification parameters:

NCV: 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 = $\sqrt{8{,}88 : 10 = 0{,}94}$).

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

The lower limit of the 95 % confidence interval is calculated according to the equation in 8.1 and is 9,8 MJ/kg (ar) (= $10{,}4 - 1{,}96 \times 0{,}94 : \sqrt{10}$)

The calculated mean value for NCV (10,4 MJ/kg ar) is rounded down at 10 MJ/kg ar.

The calculated 95 % confidence interval for NCV (9,8 MJ/kg ar) is rounded up at 10 MJ/kg ar.

→ **Class code NCV: 4**

Cl: The arithmetic mean value is 0,94 % (d).

The standard deviation s is 0,14 % (d) (s = $\sqrt{0{,}21 : 10 = 0{,}14}$).

The upper limit of the 95% confidence interval is calculated according to the equation in 8.1 and is 1,03 % (d) (= 0,94 + 1,96 × 0,14 : √ 10)

The calculated arithmetic mean value for Cl is rounded down at 0,9 % (d).

The calculated 95 % confidence interval for Cl is rounded up at 1,0 % (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) (10/0,8 = 8; 0,030 + 0,032 : 2 = 0,031)

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 up at 0,03 mg/MJ ar.

→ **Class code Hg: 1**

	Arithmetic Mean value	Standard-deviation	95 % confidence interval		Median value	80th percentile
			Upper limit	Lower limit		
NCV MJ/kg (ar)	10	0,94	-	10	-	-
Cl % (d)	0,9	0,14	1,0	-	-	-
Hg mg/MJ (ar)	-		-	-	0,02	0,03

Class Code: NCV 4; Cl 3; Hg 1

EXAMPLE 2 Production volume 50 000 tonnes per year (Figure D.2)

SRF is produced in an existing production unit. The same type of SRF is produced for the whole period. The considered production period is 12 months (from April until March). The production volume is 50 000 tonnes/year. The lot size is 1 500 tonnes corresponding to the maximum weight of a lot according to the compliance rules for the classification. The number of lots during the considered production period is 33 (50 000 : 1 500 = 33).

Following the EN 15442 at least 24 increments have to be taken on a regular basis and collected to a combined sample for each lot. Each combined sample shall be analysed for the classification characteristics (NCV, Cl, Hg). The classification code is calculated as shown in Example 1 for the first 10 data sets, and then for the consecutive 10 data sets (numbers 11 to 20) and for the remaining 10 (numbers 21 to 30). The highest class are used for the determination of the class of the SRF.

The remaining three lots (No 31-33) are used for the determination of the class code of the following production period and are completed with consecutive measurements.

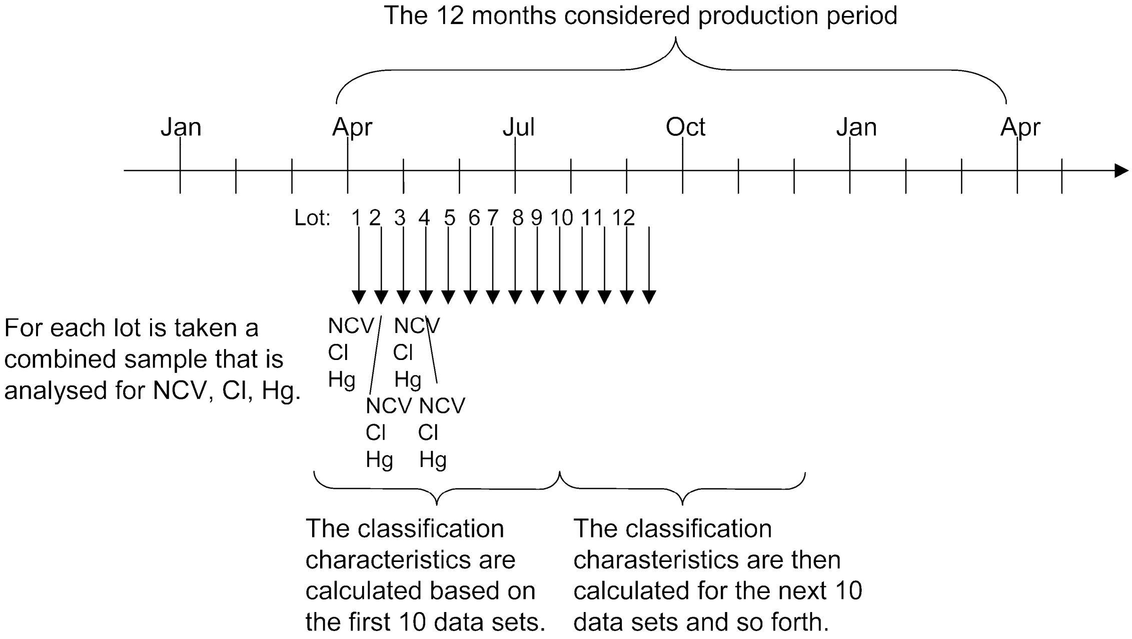

Figure D.2 — Example 2

EXAMPLE 3 Production of a specific SRF during a 6 months period (Figure D.3)

An existing production unit produces a new type of SRF during a period of 6 months. After that is switched to production of another SRF. The production volume during the 6 months period is 10 000 tonnes. The lot size is 1 000 tonnes and based on the actual production volume (10 000 : 10). The number of data sets are 10 (10 000 : 1 000 = 10). A combined sample is collected from each lot. Each combined sample is analysed for NCV, Cl and Hg. The classification code is calculated as shown in Example 1.

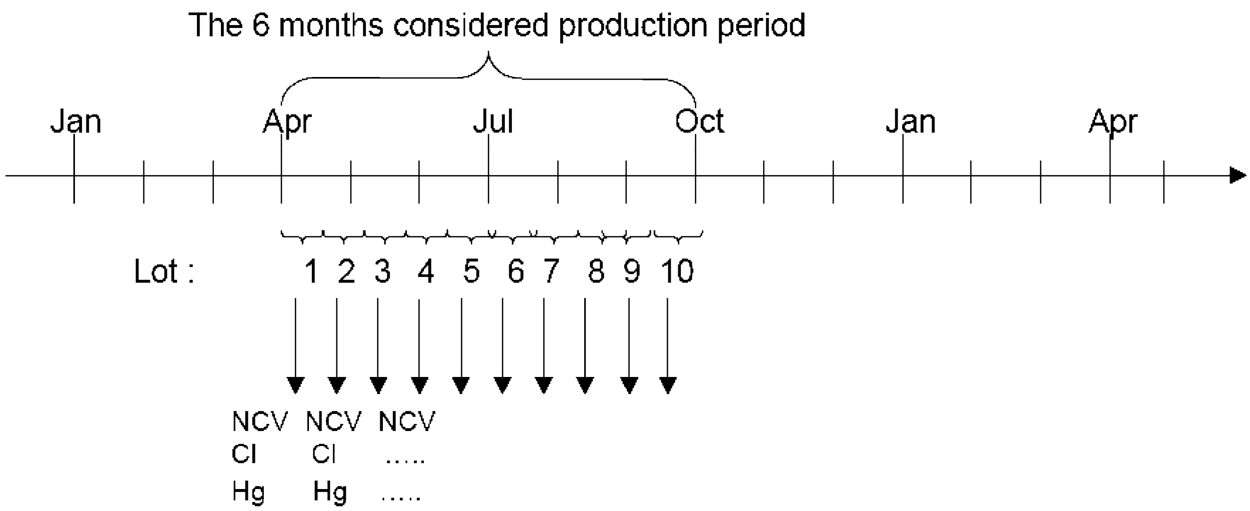

Figure D.3 — Example 3

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5) Future Directive under development.

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