

End of Waste criteria for inert aggregates in member states

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Abstract

The objective of this report is to study the consistency of the EoW criteria among different European countries. In the Netherlands there is one regulation with EoW criteria, specifically for construction and demolition waste. Comparable regulations for inert aggregates are available for the United Kingdom, France and Austria. These EoW criteria for construction and demolition waste (inert aggregates) among the four countries the Netherlands, United Kingdom, France and Austria are compared in this report. An overview of other EU and national EoW regulations is given. The consequences for other legislations, that is REACH, are addressed.

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Summary

The revised Waste Framework Directive (WFD) contains provisions to define End of Waste (EoW) criteria that provide a high level of environmental protection and an economic benefit. The rationale of the establishment of EoW criteria is to facilitate and promote recycling and use of waste materials as resources, reduce consumption of natural resources and reduce the amount of waste for disposal.

The objective of this report is to study the consistency of the EoW criteria among different European countries. In the Netherlands there is one regulation with EoW criteria, specifically for construction and demolition waste. Comparable regulations for inert aggregates are available for United Kingdom, France and Austria. Therefore, these EoW criteria for construction and demolition waste (inert aggregates) among the four countries are compared in this report. An overview of other EU and national EoW regulations is given. The consequences for other legislations, that is REACH, are addressed.

National EoW regulations for inert aggregates: The EoW regulations for construction and demolition waste of the four European member states are closely related with regard to purpose and quality aspects. However, there are also several differences in the scope of materials, quality criteria and assessment methods.

Input materials: The comparison of input materials (Waste catalogue codes) indicates that other member states incorporate more categories of aggregate materials in their EoW regulations than the Netherlands.

Quality criteria: The list of parameters for total composition and leaching is quite different among the four countries and this implies that the import/export of these materials cannot, a priori, be done without additional requirements from member states. The environmental criteria for construction and demolition waste show important similarities, in that most member states base the criteria on the leaching of these materials. However, the list of substances that are regulated differ among the member states. In addition, the UK does not use leaching criteria for the EoW regulation.

Because of the differences among the national regulations, the EoW criteria for construction and demolition waste are currently only applicable for domestic transport and use. For import and export of recycled granulate (with EoW status) it would be easier if there is a harmonised EU regulation. Furthermore, many EU member states do not (yet) have a regulation for EoW. When there is no EoW regulation, the recycled granulate is still defined as waste in the receiving country and the material has to fulfil the waste regulations (WFD), which implies that there is no advantage for an EoW status for the exporting country.

EU EoW regulations: Not only the EoW regulations of single member states will increase the benefits to recycle waste streams, also the EU EoW regulations will stimulate this aim. The EU EoW regulations for metal scrap, glass cullet and copper scrap are therefore a good way to stimulate recycling and simplify this regulatory procedure to create economic and environmental benefit. EU EoW regulations for other waste streams like waste paper, biodegradable waste (compost/digestate), waste plastic, aggregates and waste-derived fuels, would increase the economic and environmental benefits to recycle those waste streams.

To conclude, EoW regulations can improve the functioning of the internal market, because waste ceases to be waste and can be used again more easily (less administrative burdens). The removal of this barrier can contribute to a higher recycling rate of materials. The EoW status also increases the possibilities of high quality secondary materials, which will be promoted by this regulation.

At the moment, unnecessary administrative burdens are not always removed, because when the EoW status is achieved, the material may need a REACH registration (depending on the type of recovered material). It is not always clear how to deal with these regulations and therefore also the user perception is not yet improved.

The national EoW regulations can create a European market if (1) all member states introduce EoW regulations and (2) the regulations are harmonised across the different EU member states.

The reported findings represent the state of the art of the international developments regarding EoW criteria and can be used for further policy developments, for example the proposed international Green Deal regarding the establishment of a North Sea Resources Roundabout.

1

Introduction

The revised Waste Framework Directive (WFD) contains provisions to define End of Waste (EoW) criteria that provide a high level of environmental protection and an economic benefit (European Parliament and Council, 2008). Certain specified waste shall cease to be waste, when it has undergone a recovery operation and complies with specific criteria developed in accordance with a number of conditions (Article 6). These conditions are:

1. The substance or object is commonly used for specific purposes;
2. A market or demand exists for such a substance or object;
3. The substance or object fulfills the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;
4. The use of the substance or object will not lead to overall adverse environmental or human health impacts.

The rationale of the establishment of EoW criteria is to facilitate and promote recycling and use of waste materials as resources, reduce consumption of natural resources and reduce the amount of waste sent for disposal. This practice should ensure a high level of protection of the environment and the economic feasibility of the process by:

- Improve the functioning of the internal market.
- Increase recycling capacity.
- Remove unnecessary administrative burdens.
- Promote higher quality of secondary materials.
- Improve user perception.

The criteria shall include limit values for pollutants where necessary and shall take into account any possible adverse environmental effects of the substance or object.

The objective of this report is to study the consistency of the existing EoW regulations among EU member states (MS).

In the Netherlands there is one regulation with EoW criteria, specifically for construction and demolition waste. Comparable regulations for inert aggregates are available for United Kingdom, France and Austria. Therefore, the available EoW criteria

for inert aggregates of the Netherlands, United Kingdom, France and Austria are compared in this report.

The Dutch regulation for the EoW status of recycling granulate (Regeling vaststelling van de status einde-afval van recyclinggranulaat; Ministerie van Infrastructuur en Milieu, 2015) will be used as a basis for comparison of the EoW criteria among the mentioned member states. Recycling granulate is the end product from processing construction and demolition (C&D) waste. Furthermore, an overview of other EU and national EoW regulations will be given. The consequences for other legislations, that is REACH, are addressed.

The results of the report can be used to support the policy development regarding international developments on waste and material utilisation. For example, to realise the goals within the international Green Deal North Sea Resources Roundabout (NSRR).

2

End of Waste criteria for inert aggregates

Focussing on waste-derived aggregates, only four EU member states have developed EoW criteria, United Kingdom (UK), Netherlands, Austria and France, of which the French document is still a draft version. Most other member states have regulations for the use of waste aggregates, with criteria on total content and/or leaching of pollutants (**Table 1**; update of Saveyn et al, 2014).

Table 1: Overview of the situation with respect to development of EoW criteria and regulation of utilisation of waste-derived aggregates in several EU member states.

Member state	EoW criteria?	Regulation of the use of waste aggregates?	Criteria on total content?	Criteria on leaching?	Type(s) of leaching tests required
Austria	Yes	Yes ¹	Yes	Yes	EN 12457-4 (L/S=10 L/kg)
Belgium	No	Yes ²	Yes	Yes	CEN/TS 14405 (L/S=10 L/kg)
Czech Republic	No	Yes* ³	Yes	Yes	EN 12457-4 (L/S=10 L/kg)
Denmark	No	Yes ⁴	Yes	Yes	EN 12457-1
Finland	No	Yes ⁵	Yes	Yes	CEN/TS 14405; EN 12457-3 (L/S=10 L/kg)
France	Yes (draft)	Yes ⁶	Yes	Yes	EN 12457-2 and 4 (L/S=10 L/kg)
Germany	No	Yes ⁷	Yes	Yes	EN 12457-2 and DIN 19528 (new legislation)
Hungary	No	Some ⁸	No	Yes	Not known
Italy	No	Yes ⁹	No	Yes	EN 12457-2 (L/S=10 L/kg)
Netherlands	Yes	Yes ¹⁰	Yes	Yes	CEN/TS 14405 (L/S=10 L/kg)

Member state	EoW criteria?	Regulation of the use of waste aggregates?	Criteria on total content?	Criteria on leaching?	Type(s) of leaching tests required
Poland	No	No ¹¹	No	No	
Portugal	No	Yes ¹²	No	No	
Slovakia	No	No ¹³	No	No	
Spain	No	Yes ¹⁴	No	Yes	EN 12457-4 and DIN 38414-S4
Sweden	No	Yes ¹⁵	Yes	Yes	CEN/TS 14405
United Kingdom	Yes	Yes ¹⁶	No	No	Variable, no routine testing

* considering adaptation of the Austrian guidelines

¹ Guidelines; Federal Ministry of Agriculture and Forestry, Environmental and Water Management, 2006 (Austria).

² In Flemish region; EMIS (2011). See also Böhmer et al. (2008).

³ Based on Landfill legislation; Order No. 294/2005 and Order No. 61/2010, Czech Republic.

⁴ Statutory Order No. 1662 of 21 December 2010 on recycling of residual products and soil in building and construction works and on recycling of sorted, unpolluted C&D waste. Danish Environmental Protection Agency.

⁵ Finnish Government Decree 591/2006 on reuse of some waste materials in earth construction, amended by 403/2009 and 1825/2009.

⁶ Sétra (2011), Sétra (2012a), Sétra (2012b), Ministry of Environment, France (2011): order of 18 November 2011 on the use of bottom ash from non dangerous waste incineration for road construction. Note that basic characterization relies on CEN 14405 (L/S=10 l/kg), whereas compliance testing relies on EN 12457-2 and 12457-4.

⁷ Guidelines – new regulation in preparation; LAGA (2004).

⁸ EIONET (2011) Country fact sheet – fact sheets waste policies – Hungary, http://scp.eionet.europa.eu/facts/factsheets_waste/2006_edition/Hungary.

⁹ Ministry of Environment, Italy (1997): Decree 22/97. See also Böhmer et al. (2008).

¹⁰ Soil Quality Decree. Staatscourant 20 December 2007, Nr. 247, 67-90. The Netherlands.

¹¹ Böhmer et al. (2008).

¹² Some guidelines; Coelho, A.D., Brito, J. de (2008): Construction and demolition waste management in Portugal, part of: SB07 Lisbon –Sustainable Construction, Materials and Practices: Challenges of the Industry for the New Millenium, <http://www.irbdirekt.de/daten/iconda/CIB11754.pdf>.

¹³ Act No. 223/2001 on Waste as amended in Act No. 409/2006. Slovakia.

¹⁴ Regional; Decree of February 15, 1996, Catalonia, Spain. See also Böhmer et al. (2008).

¹⁵ Guidelines; Swedish EPA (2010).

¹⁶ Guidance, case by case; <http://www.environment-agency.gov.uk>.

2.1 The Netherlands

The Netherlands have published an EoW regulation for ‘stony waste’ that is released during construction, renovation and demolishing of buildings, roads and other waste that is equivalent in terms of type and composition (Ministerie van Infrastructuur en Milieu, 2015). The wastes considered to be ‘stony waste’ that are acceptable for the production of recycling aggregates, are from the construction and demolition wastes category and have the following European Waste Catalogue (EWC) codes (Commission Decision, 2000; Table 5)): 17 01 01 (concrete), 17 01 02 (bricks) and 17 01 07 (mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06 (containing dangerous substances)).

This regulation describes the requirements for the input materials, the product control, product quality and quality assurance for recycling granulate to obtain the status of End of Waste.

Input material

The stony waste must be classified as non-hazardous waste. In addition, the waste is not allowed to contain asbestos and materials containing asbestos, tar-containing asphalt (PAHs), roofing materials, household waste plaster, soil, soot and wood to an extent that may affect the quality of the recycling granulate. Also, other materials or substances are not allowed to be present to an extent that may affect the quality of the recycling granulate.

Production control

The recycling granulate must be inspected following the applicable standards and a check of the presence of asbestos must take place. The addition of secondary raw materials during or after the production of the recycling granulate is allowed, when this is done following a product standard that is mentioned in the appendix of the Dutch EoW regulation and when the final product of the recycling granulate meets all requirements of this EoW regulation.

Product quality

Recycling granulate for use on or in soil, groundwater or surface water must meet specific composition and emission values (Annex A Soil Quality Regulation; Ministerie van VROM, 2007). There are limits for bound and unbound aggregates (open application) and IBC-materials (closed application; IBC = Isolation, management and control (**Appendix A**, Table A.1)).

For recycling granulate used in asphalt, the composition value of PAHs (sum of 10 PAHs) may not exceed 75 mg/kg dw. The maximum contaminant levels in the recycling granulate may not exceed 10 cm³/kg for contaminants with a mass of 1,000 kg/m³ or less and 1% for contaminants with a mass exceeding 1,000 kg/m³ (EN 13242).

Quality assurance

The quality assurance system includes procedures for the acceptance of stony waste for processing into recycling granulate, process control, sampling, testing and inspection and registration of tests and inspections. The quality assurance complies with EN 13242.

Other regulations

Besides the EoW criteria for recycling granulate, there are no initiatives known in the Netherlands to regulate other types of waste. There is a possibility for single companies to assess their own material or object status. Therefore, companies can submit a request to the Department of Waterworks of the Ministry of Infrastructure and the Environment (Rijkswaterstaat) for examination whether the material from a production process is a byproduct (Article 5 WFD) or if it has EoW status (Article 6 WFD).

Rijkswaterstaat is using several national and European legislation and regulations for these examinations, including the Waste Framework Directive (2008/98/EG) and the Dutch Laws of Environmental Conservation (Wet Milieubeheer).

2.2 United Kingdom

The United Kingdom has an EoW regulation for the production and use of aggregates from inert waste (Environment Agency, 2013). This quality protocol is applicable in England, Wales and Northern Ireland. The waste materials considered to be inert waste that is acceptable for the production of recycled aggregates, are listed in Table 2 with their waste (EWC) codes (Commission Decision, 2000; Appendix C, Environment Agency, 2013.)

Table 2: Waste materials considered to be inert waste that is acceptable for the production of recycled aggregates with their waste codes for the UK. Right column: EWC (European waste codes).

<i>Wastes from physical and chemical processing of non-metalliferous minerals (01 04)</i>	
waste gravel and crushed rocks other than those in 01 04 07 (dangerous substances)	01 04 08
waste sand and clays	01 04 09
<i>Wastes from thermal processes (10) (10 11: from manufacture of glass and glass products)</i>	
waste glass-based fibrous materials	10 11 03
<i>Packaging (including separately collected municipal packaging waste (15))</i>	
glass packaging	15 01 07
<i>Construction and demolition waste (17)</i>	
concrete	17 01 01
bricks	17 01 02
tiles and ceramics	17 01 03
mixtures of concrete, bricks, tiles and ceramics other than those in 17 01 06 (dangerous substances)	17 01 07
glass	17 02 02
bituminous mixtures other than those in 17 03 01 (coal tar)	17 03 02
soil and stones other than those in 17 05 03 (dangerous substances)	17 05 04
dredging spoil other than those in 17 05 05 (dangerous substances)	17 05 06
track ballast other than those in 17 05 07 (dangerous substances)	17 05 08
mixed construction and demolition wastes other than those in 17 09 01, 17 09 02 and 17 09 03 (mercury, PCB and dangerous substances)	17 09 04
<i>Wastes from the mechanical treatment of waste not otherwise specified (for example sorting, crushing, compacting, pelletising; 19 12)</i>	
glass	19 12 05
minerals (for example sand, stones)	19 12 09
<i>Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions (20)</i>	
glass	20 01 02
soil and stones (garden and park wastes, including cemetery waste)	20 02 02

This regulation consists of requirements for the input materials, the production of the recycling granulate and the product quality with a quality assurance for recycled aggregates that cease to be waste.

Input material

The only acceptable input materials are the inert waste materials specified in **Table 2**. The inert waste materials, are not allowed to contain or are contaminated with dangerous substances as described in the List of Wastes of England, Wales and Northern Ireland (Regulations 2005). Incidental quantities of inert physical contaminants (such as soil, peat, clays, silts, wood, plastics, rubber, metal) that may be present in inert wastes, must be removed during the processing of the waste. A part of these inert physical contaminants are also listed in **Table 2**, but these waste classes should not be mixed together to be considered for acceptance for EoW. The maximum permitted constituents of cohesive constituents (for instance clay and soil), metals, wood, plastic, rubber and gypsum plaster is 1% by mass. The maximum permitted amount (based on volume) of floating material is $\leq 10 \text{ cm}^3/\text{kg}$ unbound or $\leq 5 \text{ cm}^3/\text{kg}$ aggregates for concrete.

Production control

The processing, sampling and testing of the recycled aggregates must be in accordance with the approved standard (EN aggregates standards) appropriate to the use for which the aggregate is destined for. The aggregate must require no further processing, including size reduction.

Product quality

The aggregates must comply with all requirements of a BS EN aggregates standard appropriate to the use for which the aggregate is destined for.

- BS EN 13242: aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction.
- BS EN 12620: aggregates for concrete.
- BS EN 13043: aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas.
- BS EN 13108-8: bituminous mixtures – material specifications – part 8: reclaimed asphalt.
- BS EN 16236: evaluation of conformity of aggregates – initial type testing and factory production control.

The United Kingdom has no criteria on leaching or total content of the produced aggregate. The aggregates must be produced according to a recognised product standard and/or specification. This specification will define the properties and characteristics of the product as suitable for its application. When the produced aggregates comply with the Quality Protocol, the aggregates has ceased to be waste.

Quality assurance

There must be a statement that the product is produced in compliance with the Quality Protocol. The testing and procedures must be in accordance with the standards as specified above in the product quality part.

2.3 Austria

Austria has an EoW regulation for construction and demolition waste for the production and classification of recycled construction materials as non-waste (Ministry for Agriculture, Forestry, Environment and Water Management, 2014). The waste materials permissible for the manufacturing of recycled construction materials and their waste (EWC) codes (Commission Decision, 2000) are listed in **Table 3**.

Table 3: Wastes considered to be waste that is permissible for manufacturing of recycled construction materials with their waste codes for Austria. Right column: EWC (European waste codes).

<i>Wastes from thermal processes (10) (wastes from the iron and steel industry; 10 02)</i>	
wastes from the processing of slag	10 02 01
unprocessed slag	10 02 02
<i>Construction and demolition waste (17)</i>	
concrete	17 01 01
bricks	17 01 02
tiles and ceramics	17 01 03
mixtures of concrete, bricks, tiles and ceramics other than those in 17 01 06 (dangerous substances)	17 01 07
bituminous mixtures other than those in 17 03 01 (coal tar)	17 03 02
soil and stones other than those in 17 05 03 (dangerous substances)	17 05 04
track ballast other than those in 17 05 07 (dangerous substances)	17 05 08
<i>Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions (20)</i>	
soil and stones (garden and park wastes, including cemetery waste)	20 02 02
street-cleaning residues	20 03 03

This regulation consists of requirements for the input materials, the production of the recycling granulate and the product quality with a quality assurance for recycled construction material that ceases to be waste.

Input material

Austria has its own codes for waste types. The specific waste types that are permissible for the manufacturing of recycled construction materials are listed in Annex 1, Table 1 of the Austrian EoW regulation. These Austrian codes can be translated to the European waste codes (**Table 3**). Pollution by the following substances or wastes must be avoided as far as possible: asbestos, artificial mineral fibres, (H)FCKW (for example XPS, PU), PAH (for instance tars), PCB, phenols, gypsum, magnesite- cement-bonded wood wool insulating building panels, cement-bonded wood concrete, fire protection panels, artificial marble. Specific amounts are not given.

Production control

The environmental sustainability of the manufactured recycled construction materials must be ensured by compliance of the material performance with respect to leaching and total content limits and quality requirements for the specific quality classes that are

specified in the regulation. The chemical analyses must be carried out by accredited conformity assessment.

Product quality

The quality requirements for recycled construction materials (quality classes, requested parameters and their limits) must be in accordance with specific leaching and total content limits (Annex 2, Ministry for Agriculture, Forestry, Environment and Water Management, 2014; Appendix A, Table A.2). The recycled construction material should be assigned to a quality class in accordance with proposal of ÖNORM B 3140 (Recycled aggregates for the construction industry). There are eight aggregate quality classes, for unbound aggregates (U-A, U-B and U-E), for hydraulic binding (H-B), for bituminous binding (B-B, B-C and B-D) and steel mill slag (D). the U-A quality class for aggregates for unbound and hydraulically or bituminously bound use is applied to classify the material as non-waste.

Quality assurance

The quality assurance system include procedures for classification, sampling, examination of the recycled construction materials. The provisions of the national Landfill Regulation 2008, Annex 1, Part 1, Chapter 5 apply to exploration, leaching and determination methods for analytical chemical tests (Federal Law Gazette II, 2008).

2.4 France

France has an EoW regulation for aggregates produced from construction and public works to be used in road building (Ministry of Ecology Sustainable Development and Energy, 2015). Wastes that are accepted for the production of aggregates are from the construction and demolition wastes category and have the following waste (EWC) codes (Commission Decision, 2000; **Table 4**).

Table 4: Input waste for the recycling operation with their waste codes for France. Right column: EWC (European waste codes).

<i>Wastes not otherwise specified(16) (off-specification batches + unused products; 16 03)</i>	
inorganic wastes other than those in 16 03 03 (dangerous wastes)	16 03 04
<i>Construction and demolition waste (17)</i>	
concrete	17 01 01
bricks	17 01 02
tiles and ceramics	17 01 03
mixtures of concrete, bricks, tiles and ceramics other than those in 17 01 06 (dangerous substances)	17 01 07
glass	17 02 02
bituminous mixtures other than those in 17 03 01 (coal tar)	17 03 02
soil and stones other than those in 17 05 03 (dangerous substances)	17 05 04
<i>Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions (20)</i>	
soil + stones (garden / park wastes, including cemetery waste), except soil	20 02 02

This regulation consists of requirements for the input materials, the production of the recycling granulate and the product quality with a quality assurance for recycling granulate that ceases to be waste.

Input material

The only waste materials that are accepted as input, are listed in **Table 4**. Furthermore, among the inputs, waste with a dryness of under 30%, a temperature of over 60°C, powdered and radioactive waste may not be present. Wastes with waste code 17 03 02 is explicitly mentioned because this type of waste must be checked specifically on PAHs and asbestos.

Production control

All necessary processes must be carried out in order to prepare the aggregates for their direct and final use as road building materials. The produced aggregates shall be segregated by family of materials (CONCRETE, ASPHALT, or MIXED; NF EN 933-11; NF EN 13108-8) and by type of authorised use (type 1, 2 or 3).

Product quality

The aggregates shall comply with the applicable legislation and standards for the road building use in question, especially:

- NF P 11-300 for aggregates suitable for use in the construction of road infrastructure embankments and subgrades.
- NF P 18-545 for aggregates suitable for use in road construction.
- NF EN 13242+A1 concerning aggregates for unbound and hydraulically bound materials for use in road construction.
- NF EN 13285 concerning aggregates for untreated gravel, suitable for use in the construction of road subgrades.
- NF EN 13108-8 concerning asphalt aggregates for bituminous mixtures, hydrocarbon mixtures and for the surface coating of roads, aerodromes and other trafficked zones.

The aggregates must meet specific environmental limits (Ministry of Ecology Sustainable Development and Energy, 2015; Appendix A, Table A.1). The aggregates are segregated by family of materials (CONCRETE, ASPHALT or MIXED) and by type of authorised use (Type 1, 2 or 3 road building use). These limits are tested according to the leaching analysis following NF EN 12457-2 or NF EN 12457-4. Furthermore, aggregates produced from construction and public works waste must contain less than 5 cm³/kg of floating materials and no more than 1% by mass of foreign material (ferrous and non-ferrous metals, soil and clay, gypsum, wood, plastic, rubber and insulating material; in accordance with NF EN 933-11).

Quality assurance

When the final product meets the criteria, the compliance certificate shall indicate the type of use that may be made of the material and any restrictions on their use.

3

Comparison of EoW regulations within the EU

3.1 Requirements and quality of waste material (input)

Input material

For inert aggregate EoW regulation in The Netherlands, United Kingdom, Austria and France, the wastes used as input material are classified with waste (EWC) codes following the waste categories listed in the Commission Decision of 3 May 2000 (Commission Decision, 2000;Table 5).

There are quite some differences in input materials among the member states, but construction and demolition waste, to be more specific, waste from concrete, bricks, tiles and ceramics (scope of the Dutch EoW regulation) is in all member states considered as input materials for recycling aggregates.

Table 5 indicates that other member states incorporate more different aggregate materials in their EoW regulations than the Netherlands. This aspect is important in the consideration of importing 'EoW aggregates' from other member states (for instance in the framework of the proposed North Sea Resources Roundabout).

Next to the waste codes of the input material, there are more agreements and differences in criteria that are required for the input material between the four member states (**Table 6**). **Table 6** shows, that the number of specific materials and compounds present in C&D waste that is not allowed in the input material, is diverse and not identical over the member states. These differences are probably related to the differences in the list of input materials (**Table 5**) and, maybe more importantly, to the common set of parameters that the authorities have regulated for similar materials/applications.

Table 5: Waste codes of input materials for EoW regulation in The Netherlands (NL), United Kingdom (UK), Austria (A) and France (F) .

Wastes from	Waste codes			
	NL	UK	A	F
Minerals		01 04 08		
		01 04 09		
Thermic processes			10 02 01	
			10 02 02	
		10 11 03		
Packaging		15 01 07		
Not specified				16 03 04
Construction and Demolition*	17 01 01	17 01 01	17 01 01	17 01 01
	17 01 02	17 01 02	17 01 02	17 01 02
		17 01 03	17 01 03	17 01 03
	17 01 07	17 01 07	17 01 07	17 01 07
Construction and Demolition		17 02 02		17 02 02
		17 03 02	17 03 02	17 03 02
		17 05 04	17 05 04	17 05 04
		17 05 06		
		17 05 08	17 05 08	
	17 09 04			
Water		19 12 05		
treatment		19 12 09		
Municipal		20 01 02		
		20 02 02	20 02 02	20 02 02
			20 03 03	

*17 01 = concrete, bricks, tiles and ceramics.

Table 6: Other specifically mentioned requirements for the input materials as waste material (X = materials that are not allowed).

Materials	NL	UK	A	F
Hazardous/dangerous	X	X		X
Asbestos	X		X ⁴	X ⁵
Tar-containing asphalt (PAHs)	X		X ⁴	X ⁵
Roofing materials	X			
Household waste	X			
Plaster	X ²	<1% ³	X ⁴	
Soil (e.g. sand, clay, peat)	X ²	<1% ³		
Soot	X ²			
Wood	X ²	<1% ³		
Metals		<1% ³		
Plastic		<1% ³		
Rubber		<1% ³		
Artificial mineral fibres			X ⁴	
(H)CKW (e.g. XPS, PU)			X ⁴	
PCB			X ⁴	
Phenols			X ⁴	
Building panels ¹			X ⁴	
Cement-bonded wood concrete			X ⁴	
Fire protection panels			X ⁴	
Artificial marble			X ⁴	
Powdered material				X
Radioactive material				X
Other material	X ²			X ⁶

¹ magnesite- cement-bonded wood wool insulating building panels.

² to an extent that may affect the quality of the recycling granulate.

³ by mass, maximum permitted after removal during processing of the waste.

⁴ must be avoided as far as possible.

⁵ 17 03 02 must be checked specifically.

⁶ waste with dryness under 30%, temperature of over 60°C.

3.2 Requirements and quality of EoW material

Standards

For the production control, product quality and quality assurance, several standards are used (**Table 7**). The standards used in the four member states generally show much agreement. Additional product standards that are used in other member states (for example EN13285 for railway ballast in the UK) are mainly related to the inclusion of different materials. The main difference in the standards used are found with respect to the leaching test standards. The Netherlands uses a percolation leaching test (NEN 7373) on materials with a particle size <4 mm (after size reduction), while Austria and France use batch leaching tests with materials either <10 mm or <4mm. The UK does not prescribe any leaching test for the products.

Table 7: Used standards within the EoW regulations. Standards used in only one member state are shown in italics.

Control	NL	UK	A	F
Sampling	EN 932-1		EN 932-1	
Composition	EN 933-11	EN 933-11 <i>EN 933-1</i> <i>EN 1097-2 & 6</i> <i>EN 1744-1 & 5 & 6</i>		EN 933-11
Leaching	<i>NEN 7373</i>		EN 12457-4	EN 12457-2 EN 12457-4
Quality	EN 13242+A1 EN 12620 EN 16236	EN 13242 EN 12620 EN 16236 EN 13285 EN 13108-8 (+ 1 to 5) EN 13043 <i>EN 14227-1 to 5</i>	<i>ÖNORM B 3140</i> <i>ÖNORM B 4710-1</i> <i>ÖNORM B 3580-1 or 2</i> EN 13108-1 EN 13043	EN 13242+A1 <i>P 11-300</i> <i>P 18-545</i> EN 13285 EN 13108-8

Requirements for total composition of materials

An overview of the requirements for the total composition of the EoW materials is listed in **Table 8**. More details on specific materials and components are listed in **Appendix A** (Table A.3 and A.4). This comparison clearly shows, that there are substantial differences in the parameters to be analysed. In addition, the requirements for PAH in the material can vary substantially, depending on the targeted application. The results indicate that the list of parameters for total composition is quite different for the four countries and this implies that the import/export of these materials cannot be done a priori without additional requirements from member states.

Table 8: Maximum values for total composition of the EoW materials.

Materials	NL	UK	A	F
Asbestos	100 mg/kg			
Tar-containing asphalt (PAHs)	50 mg/kg ¹⁾		12-300 mg/kg ⁴⁾	50-500 mg/kg
Hydrocarbons (C10-C21)				300 mg/kg
PCB	0.5 mg/kg			1 mg/kg
BTEX	4.75 mg/kg			6 mg/kg
Mineral oil	500 mg/kg			
Phenols	1.25 mg/kg			
TOC				30-60 g/kg
Floating materials		5-10 cm ³ /kg ²⁾	2-5 cm ³ /kg	5 cm ³ /kg
Metals		1% ³⁾	χ ⁵⁾	1% ³⁾
Soil (e.g. sand, clay, peat)		1% ³⁾	1% ³⁾	1% ³⁾
Gypsum		1% ³⁾	1% ³⁾	1% ³⁾
Wood		1% ³⁾	1% ³⁾	1% ³⁾
Plastic		1% ³⁾	1% ³⁾	1% ³⁾
Rubber		1% ³⁾	1% ³⁾	1% ³⁾
Insulating material				1% ³⁾

¹⁾ ∑10PAH; ²⁾ aggregates for concrete and unbound respectively; ³⁾ by mass; ⁴⁾ ∑16PAH, amount depending on aggregate class; ⁵⁾ see **Appendix A**, Table A.4 for values of the specific metals.

Leaching

To compare the environmental limits for the recycled aggregates among the member states, the leaching criteria of the classes with the lowest limits are listed below (**Table 9**). For the Netherlands the emission limits for unbound materials are used. For Austria the U-A quality class, which are aggregates for unbound and hydraulically or bituminous bound use, is selected. For France the CONCRETE family is used, which have the same values for the type 1, 2 and 3 road building use. The United Kingdom has no criteria on leaching or total content. The aggregates must be produced to a recognised standard and/or specification. An overview of all emission criteria is listed in **Appendix A**, Table A.1 and A.2.

Table 9: Leaching criteria for the Netherlands, Austria and France of the classes with the lowest limits. The most stringent limit values are marked red and bold.

Member State	Netherlands	Austria	France
Class	unbound	U-A	CONCRETE
unit	mg/kg dw	mg/kg dw	mg/kg dw
Parameter	L/S 10	L/S 10	L/S 10
Antimony (Sb)	0.32		0.08
Arsenic (As)	0.9		0.6
Barium (Ba)	22		25
Cadmium (Cd)	0.04		0.05
Chrome (Cr)	0.63	0.3	0.6
Cobalt (Co)	0.54		
Copper (Cu)	0.9	0.6	3
Mercury (Hg)	0.02		0.01
Lead (Pb)	2.3		0.6
Molybdenum (Mo)	1	0.5	0.6
Nickel (Ni)	0.44	0.4	0.5
Selenium (Se)	0.15		0.1
Tin (Sn)	0.4		
Vanadium (V)	1.8	0.5	
Zinc (Zn)	4.5		5
Bromide (Br)	20		
Chloride (Cl)	616	800	1000
Fluoride (F)	55	10	13
Sulfate (SO ₄)	1,730	2,500	1,300

Table 9 shows the differences of the emission criteria among the Netherlands, Austria and France. It has to be taken into account, that the criteria in the Netherlands are based on a percolation leaching test (NEN 7373) and that the other countries have used a batch leaching test (EN12457) for estimation of criteria. The United Kingdom has no specific leaching criteria. Generally, the leaching criteria are quite comparable and in case of substantial differences, the Dutch criteria are mostly higher than the other member states (except for Cl, SO₄ and Cu). On the other hand, Austria and the UK have no leaching limit values for a considerable number of substances in comparison with the Netherlands. This implies that materials with the EoW status cannot be readily accepted

in the Netherlands without further testing of the emission of these contaminants (different test methods and substances to be analysed). When materials are exported from the Netherlands, the producers need to check whether the products meet the mostly lower limit values in other member states. In addition, a better insight in the comparability of test results from the percolation test and the batch test needs to be gained to judge the specified emission limits in **Table 9**.

Saveyn et al (2014) stated that a leaching limit value is meaningless without reference to a specific leaching test (or specific test conditions). Therefore, it is important to know how the limits are measured (test method; L/S) and for which intended scenario it will be applied, to be able to compare the limits. They also advised not to adopt the EU inert landfill Waste Acceptance Criteria (WAC; **Table 10**) directly as leaching limit values for EoW. The principles of the methodology are recommended to adopt, but need to be adjusted to the EoW situation and the list of substances should be increased. The limit values should reflect the conditions of use associated with the EoW status of aggregates, that is for instance free use or restricted exposure.

For calculation of leaching limits for EoW without restrictions or conditions (JRC, **Table 10**), the starting point is, that the concentration of the substances in the porewater in the aggregate application should not exceed the primary water quality criteria (Saveyn et al, 2014). These limits are very stringent and will most likely be extremely difficult to comply with for most waste-derived aggregates.

Table 10: Leaching criteria suggested for EoW without restrictions or conditions (JRC) and the EU inert landfill Waste Acceptance Criteria (WAC).

	JRC ¹	WAC ²
unit	mg/kg	mg/kg
Parameter	L/S 10	L/S 10
Antimony (Sb)	0.012	0.06
Arsenic (As)	0.037	0.5
Barium (Ba)	0.049	20
Cadmium (Cd)	0.00017	0.04
Chrome (Cr)	0.094	0.5
Copper (Cu)	0.041	2
Mercury (Hg)	0.0079	0.01
Lead (Pb)	0.0012	0.5
Molybdenum (Mo)	0.057	0.5
Nickel (Ni)	0.01	0.4
Selenium (Se)	0.027	0.1
Zinc (Zn)	0.011	4
Chloride (Cl)	280	800
Fluoride (F)	6.2	10
Sulfate (SO ₄)	750	1,000
DOC	15	500

¹ Joint Research Centre; leaching limits for EoW for aggregates without restrictions and control of use (Saveyn et al, 2014)

² Waste Acceptance Criteria of inert material for landfill (Council Decision, 2003).

4

EoW regulations for other waste streams

4.1 National EoW regulations

Besides the EoW regulation for construction and demolition waste, several EU Member States have EoW regulations for other types of waste (**Table 11**).

Table 11: Overview of EoW regulations in member states (MS).

MS	Type of waste	Document title	EU reference
Austria	construction	the Recycled Construction Materials Regulation	2014/564/A
	demolition	Guidelines for recycled building materials from building demolition waste ¹	2007/653/A
	wood	Ordinance of the Federal Minister for Agriculture and Forestry, the Environment and Water Management on the Recycling of Waste Wood in the Wood Material Industry (Recycled Wood Ordinance)	2011/551/A
	ash	Decree of the Federal Minister for Agriculture, Forestry, Environment and Water Management and of the Federal Minister for Economics, Family and Youth, amending the Waste Incineration Ordinance (AVV Amendment 2009)	2009/633/A
	trench filling materials	Guideline for free-flowing, self-compacting trench filling materials containing recycled, crushed material ¹	2007/654/A
France	construction and demolition	Order setting end-of-waste criteria for aggregates produced from waste from construction and public works, to be used in road building	2015/77/F (draft)
	wood	Order establishing criteria for the declassification as waste of shredded wood from packaging for use as biomass fuel in combustion plants.	2014/144/F
	cooking oil / animal	Order defining the end-of-waste criteria for waste	2016/179/F

MS	Type of waste	Document title	EU reference
	fat	from animal fat, used cooking oil and biofuels made therefrom and intended for use as fuel in a combustion plant with a thermal input greater than 0.1 MW and classified under heading 2910-B of the nomenclature of plants classified for environmental protection	
	oil distillation residues	Order setting end-of-waste criteria for used-oil distillation residues, for use as bitumen plasticisers in the manufacture of waterproof roofing membranes	2016/89/F (draft)
United Kingdom	Inert	End of Waste Criteria for the production of aggregates from inert waste	2013/107/UK
	steel slag	End of waste criteria for the production and use of steel slag aggregates in construction applications	2014/481/UK
	rubber	End of waste criteria for the production and use of tyre-derived rubber materials (TDRM)	2014/256/UK
	cooking oil / animal fat	End of waste criteria for the production and use of biodiesel derived from waste cooking oil and rendered animal fat	2013/613/UK
	biodegradable	Quality Protocol Anaerobic digestate End of waste criteria for the production and use of quality outputs from anaerobic digestion of source-segregated biodegradable waste	2013/433/UK
	gypsum	End of waste criteria for the production and use of recycled gypsum from waste plasterboard	2013/207/UK
	biomethane	End of waste Quality Protocol for biomethane for injection into the gas grid, or for use as a fuel in suitably designed appliances	2013/187/UK
	poultry litter ash	End of waste criteria for the production and use of treated ash from the incineration of poultry litter, feathers and straw	2012/5/UK
	biodegradable	End of Waste Criteria for the production and use of quality compost from source - Segregated biodegradable waste.	2011/542/UK
	ash	End-of-waste criteria for the production of pulverised fuel ash (PFA) and furnace bottom ash (FBA) for use in construction and manufacturing	2010/161/UK
	lubricating oils	End of waste criteria for the production and use of processed fuel oil from waste lubricating oils	2009/473/UK
	flat glass	End of waste criteria for the production of processed cullet from waste flat glass	2008/324/UK
	plastic	End of waste criteria for the manufacture of secondary raw materials from waste non-packaging plastics	2008/591/UK
Netherlands	construction and demolition	Recycling Granulate (End-of-Waste Status Determination) Regulation	2014/384/NL
Portugal	fertilising material	Draft Decree relating to fertilisers	2014/132/P
	rubber	Ministerial Implementing Order establishing the criteria for the assignment of end-of-waste status to rubber material derived from used tyres	2016/401/P (draft)
	plastic	Ministerial Implementing Order establishing the criteria for the conferral of end-of-waste status to recovered plastic	2016/402/P (draft)
Slovenia	biodegradable	Decree on the treatment of biodegradable waste and the use of compost or digestate	2013/361/SL
Italy	Solid Recovered Fuel (SRF)	Regulation governing end-of-waste status to determine types of Solid Recovered Fuel (SRF)	2012/480/I

MS	Type of waste	Document title	EU reference
Estonia	biodegradable	Requirements for production of compost from biodegradable waste	2012/458/EE
Ireland	gypsum	Proposed (draft) position on end-of-waste for recycled gypsum	2010/350/IRL
	tyre bales	Proposed (draft) position on end-of-waste status for tyre bales	2010/344/IRL
Iceland	Not defined	REGULATION on the recovery of waste	2015/9013/IS

¹ to get a quality mark for recycled building material, not the status 'EoW', because the documents are from before the WFD of 2008.

For construction and demolition waste, the EoW regulations are based on total content and leaching criteria of pollutants, while other criteria are applied for other types of waste as will be illustrated for different waste types below.

For example, Austria and France have EoW regulations for waste wood. The United Kingdom and Ireland have EoW regulations for waste tyres and gypsum. The United Kingdom has also EoW regulations for flat glass and plastic. The EoW criteria for these waste types will be listed below.

Wood

Austria (2011/551/A)

In Austria there is an EoW regulation for recycling of waste wood in the wood material industry (companies that manufacture wood composites) and to be used as substitute fuel products. For recycling waste wood, there is an incoming inspection. Only waste types with the defined waste codes can be used as input material for recycling (Annex 1, 2011/551/A, Waste Catalogue Ordinance, 2002). The input material may not contain halogenated coatings or has hazardous properties (because of chemical treatment). Furthermore, there are threshold values and quality requirements for wood for recycling and recycling wood products of As, Pb, Cd, Cr, Hg, Zn, Cl, F and PAHs (EPA) with sampling and analysis following standards (**Table 12**; Annex 2 and 3, 2011/551/A) in order to meet the EoW criteria.

France (2014/144/F)

In France there is an EoW regulation for shredded wood from packaging, prior to its use as biomass fuel in combustion plants. Only waste types with the defined waste codes 15 01 03, 20 01 38 and 19 12 07 can be used as input material for recycling to be used as biomass fuel (Annex 1, 2014/144/F, Commission Decision, 2000). The input waste may not contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating. The shredded wood may not contain foreign bodies of a size visible to the naked eye (ferrous and non-ferrous metals, stones, earth, glass, oils, oily emulsions, lubricants, grease and PVC). Furthermore, shredded wood from packaging may not exceed the levels for Hg, As, Cd, Cr, Cu, Pb, Zn, Cl, PCP and PCB with sampling and testing following standards (Table 12; Annex 1, 2014/144/F).

Table 12: Threshold values (total content) for input materials of the EoW regulations of waste wood in Austria and France.

	Austria	France
	Threshold values (median)	Maximum content
parameter	mg/kg DM	mg/kg DM
As	1.2	4
Cd	0.8	5
Cu		30
Cr	10	30
Hg	0.05	0.2
Pb	10	30
Zn	140	200
Cl	250	900
F	15	
Total PAHs (EPA)	2	
PCP		3
PCB		2
N		1.5% (max dry matter content)

The EoW regulations for wood in Austria and France do not only differ in input materials, but also in the recycled end-products. This results in higher levels of the listed compounds in France which are only allowed for application as biomass fuel. The levels in Austria are more stringent, as the waste wood will be used in the wood material industry. As the same criteria apply for substitute fuel products in Austria, these levels are therefore more stringent than in France.

Tyres

United Kingdom (2014/256/UK)

The United Kingdom has an EoW regulation for tyre-derived rubber materials (TDRM). This material may only be produced from source-segregated waste tyres, with waste (EWC) code 16 01 03 (excluding aircraft tyres). Small amounts of contamination arising from their use or handling, such as earth, stones, grease or oils are considered to be acceptable. TDRM should be produced using either ambient or cryogenic processing technologies and must comply with approved material standards (five size categories from 0.5 up to 300 mm) and engineering standards to ensure that the material is suitable for use in the designated application and must require no further processing before use. The designated applications fit within the civil engineering (bound and unbound), landfill engineering, sports, recreation and leisure applications, industrial and consumer applications. Examples of applications are as replacement aggregate in construction and building industry, in sports, recreation and safety surfacing and in automotive, rubber matting and products.

Ireland (2010/344/IRL)

Ireland has a supplementary paper on the use of tyre bales in above ground installations for tyre bales to achieve the EoW status. For this application, tyre bales are used in a floating construction (above ground) as lightweight road foundation over soft ground. Therefore, the tyre bales must be manufactured and managed to the PAS:108

standard. A maximum of 50 tonnes of baled tyres is used in an installation and not more than necessary. The baled tyres are not stored for more than 3 months at the location of the installation prior to use. The tyre bales are used only once and a drainage from the installation is designed and constructed such that water cannot accumulate by contact with tyre bales.

The EoW regulations for tyres in the United Kingdom and Ireland differ in end-use of the recycled products and therefore the EoW criteria differ.

Gypsum

United Kingdom (2013/207/UK)

The United Kingdom has an EoW regulation for recycled gypsum from waste plasterboard. Gypsum must require no further processing for the use it is destined for (as a raw material in the manufacturing of new gypsum-based construction products or cement) and comply with all requirements of an approved standard (that is PAS:109 and metal limits; **Table 13**). The input materials are limited to waste plasterboard.

Ireland (2010/350/IRL): Ireland has a final position on EoW status for recycled gypsum. Gypsum, recovered from waste plasterboard, can achieve EoW status if the recycling process complies with the PAS:109 standard and the heavy metal testing regime (**Table 13**), quality limits and use meets the UK Environment Agency Quality Protocol.

The EoW regulations for gypsum in the United Kingdom and Ireland are closely related, as the recycling process must comply with the same standard, the input material is limited to waste plasterboard and the criteria from Ireland must meet the UK Environment Agency Quality Protocol.

Table 13: Maximum metal and metalloid values in gypsum from waste in the UK (UK Quality Protocol, 2011).

Analyte	Maximum contaminant values [mg/kg]
Arsenic	5.23
Cadmium	0.30
Chromium	17.9
Copper	32.8
Lead	31.9
Magnesium	2,412
Mercury	<2
Molybdenum	7.68
Nickel	7.31
Phosphorous	87
Potassium	1,992
Selenium	7.37
Zinc	40.3
Sulphur	209,200

Plastic

United Kingdom (2008/591/UK)

The United Kingdom has an EoW regulation for the production of secondary raw materials from waste non-packaging plastics. To achieve the EoW status, these materials have been processed in accordance with all requirements of the relevant European and British Standards (Appendix B, 2008/591/UK). Besides that, a safety data sheet must have been supplied because the REACH regulation is applicable when the waste ceases to be waste.

Glass

United Kingdom (2008/324/UK)

The United Kingdom has an EoW regulation for the production of processed cullet from waste flat glass. As input material, waste flat glass with the EWC codes 10 11 99; 16 01 20; 17 02 02; 19 12 05 and 20 01 02 are suitable for the production of cullet. The cullet must be produced with the approved standard relevant to the market into which the cullet will be sold.

This regulation does not include the use of processed cullet as an aggregate as this falls within the scope of the Quality Protocol for the production of aggregates from inert waste (2013/107/UK).

When comparing the regulations of the different member states and waste streams, the criteria vary considerably, depending not only on the waste stream, but also on the final product that will be obtained from the waste.

The United Kingdom has regulations for many different waste streams, but there are no standard threshold values for the input/waste material: the EoW materials must be produced to a recognised standard and/or specification.

4.2 European EoW regulations

Besides the EoW regulations established by the member states, the commission is establishing EoW criteria for a number of specific recyclable materials. At the moment, there are technical studies available for EoW criteria for iron and steel scrap, aluminium and aluminium alloy scrap, waste paper, copper and copper alloy scrap, glass cullet, biodegradable waste (compost/digestate) and waste plastic. So far, these studies have led to the development of the following EoW regulations, which are now adopted and came into force:

- Commission Regulation on Eow for metal scrap (222/2011; iron, steel and aluminium).
- Commission Regulation on EoW for glass cullet (1179/2012).
- Commission Regulation on EoW for copper scrap (715/2013).

In the future, the commission may develop EoW criteria on additional streams such as plastics, aggregates, and waste-derived fuels.

Waste-derived aggregates, including construction and demolition (C&D) waste, are being considered as possible candidates for development of EoW criteria at EU level as means of increasing the recovery of resources. If and when a waste-derived aggregate achieves EoW status, it will become a (construction) product and hence be regulated by the Construction Products Regulation (CPR) rather than waste legislation, which means that in most EU member states, there will be no applicable environmental protection regulation. However, environmental protection is incorporated in Basic Requirement 3 (Hygiene, health and the environment) but specific criteria for environmental quality are not included. The use of recycled waste aggregates for construction purposes are subject to environmental legislation in several EU member states, but construction products are generally not, except in The Netherlands where environmental protection regulations apply equally to both recycled waste aggregates and virgin aggregates used in construction (Hjelmar et al, 2016).

Metal scrap

The EoW regulation for metal scrap makes a distinction between iron and steel scrap and aluminium scrap. The iron and steel scrap shall cease to be waste, in case all of the following conditions are fulfilled:

- The waste used as input for the recovery operation complies with specific criteria (Section 2 of Annex I of 333/2011). In short, only recoverable iron and steel may be used, no hazardous waste, no filings and turnings that contain fluids and no barrels and containers from oil or paint.
- The waste used as input for the recovery operation has been treated in accordance with specific criteria (Section 3 of Annex I of 333/2011). In short, separation of iron and steel scrap from non-metal and non-ferrous components, mechanical treatments shall have been completed; specific requirements apply to waste containing hazardous components.
- The iron and steel scrap resulting from the recovery operation complies with specific criteria (Section 1 of Annex 1 of 333/2011). In short, grading according to requested specifications, $\leq 2\%$ of foreign material, no excessive ferrous oxide, free from oily material and radioactivity, no hazardous properties (Annex III of 2008/98/EC) or in a state to cause explosion in a metalwork furnace.

- The producer has satisfied the requirements set out in Articles 5 (= Statement of conformity) and 6 (= Quality management).

The aluminium scrap shall cease to be waste, in case all of the following conditions are fulfilled:

- The waste used as input for the recovery operation complies with specific criteria (Section 2 of Annex II of 333/2011). In short, only recoverable aluminium may be used, no hazardous waste, no filings and turnings that contain fluids and no barrels and containers from oil or paint.
- The waste used as input for the recovery operation has been treated in accordance with specific criteria (Section 3 of Annex II of 333/2011). In short, separation of aluminium scrap from non-metal and non-aluminium components, mechanical treatments shall have been completed; specific requirements apply to waste containing hazardous components.
- The aluminium scrap resulting from the recovery operation complies with specific criteria (Section 1 of Annex 1 of 333/2011). In short, grading according to requested specifications, $\leq 5\%$ of foreign materials or the metal yield shall be $\geq 90\%$, free from oily material and radioactivity, no hazardous properties (Annex III of 2008/98/EC) or in a state to cause explosion in a metalwork furnace.
- The producer has satisfied the requirements set out in Articles 5 (= Statement of conformity) and 6 (= Quality management).

Glass cullet

The EoW regulation for glass cullet shall cease to be waste in case all of the following conditions are fulfilled:

- The glass cullet used as input for the recovery operation complies with specific criteria (Section 1 of Annex I of 1179/2012). In short, the content of non-glass components shall be ≤ 50 ppm ferrous metals, ≤ 60 ppm non-ferrous metals, < 100 ppm non-metal non glass inorganics for glass cullet size > 1 mm, $< 1,500$ ppm for glass cullet size ≤ 1 mm, $\leq 2,000$ ppm organics and shall not display any of the hazardous properties (Annex III of 2008/98/EC).
- The waste used as input for the recovery operation complies with specific criteria (Section 2 of Annex I of 1179/2012). In short, only recoverable glass may be used, no glass-containing waste from mixed municipal solid waste of healthcare waste, no hazardous waste.
- The waste used as input for the recovery operation has been treated in accordance with specific criteria (Section 3 of Annex I of 1179/2012). In short, after collection, separation and processing kept separate from other waste; mechanical treatments shall have been completed.
- The producer has satisfied the requirements set out in Articles 4 (= Statement of conformity) and 5 (= Management system).
- The glass cullet is destined for the production of glass substances or objects in re-melting processes.

Copper scrap

The EoW regulation for copper scrap shall cease to be waste in case all of the following conditions are fulfilled:

- The copper scrap resulting from the recovery operation complies with specific criteria (Section 1 of Annex I of 715/2013). In short, grading according to requested specifications, $\leq 2\%$ of foreign material, no excessive metal oxide, free from oily

material and radioactivity, no hazardous properties (Annex III of 2008/98/EC) or in a state to cause explosion in a metalwork furnace and not containing PVC.

- The waste used as input for the recovery operation complies with specific criteria (Section 2 of Annex I of 715/2013). In short, only recoverable copper may be used, no hazardous waste, no filings and turnings that contain fluids and no barrels and containers from oil or paint.
- The waste used as input for the recovery operation has been treated in accordance with specific criteria (Section 3 of Annex I of 715/2013). In short, separation of copper scrap from non-metal and non-copper components, mechanical treatments shall have been completed; specific requirements apply to waste containing hazardous components.
- The producer has satisfied the requirements set out in Articles 4 (= Statement of conformity) and 5 (= Management system).

5

Legislation in relation to EoW

Construction Products Regulation

When classified as a waste, environmental and health protection aspects of the use of C&D waste for construction purposes are regulated by national and EU waste legislation. Technical (or functional) requirements for the use of C&D waste for construction purposes are regulated under the Construction Products Regulation (CPR) by harmonised European Product Standards. The harmonised European standards for aggregates distinguish between primary, secondary and recycled aggregate and thus cover both waste materials and products used in construction.

The marketing and use of a waste-derived C&D aggregate which obtains EoW status and becomes a construction product will, as mentioned above, still be regulated by the CPR as far as the functional criteria and CE marking are concerned. Currently, CEN (European Committee for Standardisation) is working under mandates from the EU commission to implement requirements for health, hygiene and environment (in the CPR referred to as Basic Requirement no. 3) into the various product standards describing the conditions for CE marking. The product standards will describe which (harmonised) test standards must be used at EU level to measure the potential release to soil, groundwater and surface water. The criteria to be met by the test results to allow various uses of the products are, however, not set at EU level – they depend on national regulation in each member state.

Very few of the EU member states have actually set general criteria for the use of construction products. The notable exception that has such legislation is the Netherlands (SQD, 2007) and to some extent also Germany. This means that in most other European countries, a C&D material with EoW status may no longer be subject to any environmental quality criteria or specific use conditions, except for those laid down in the requirements for obtaining the EoW status itself. For the member states without an EoW regulation, this should be taken into account if and when setting the criteria and conditions for obtaining EoW status. Besides that, the Water Framework Directive (2000/60/EC) and its daughter directive, the Groundwater Directive (2006/118/EC)

must be taken into account when setting the primary water quality criteria. This is because the Water Framework Directive obliges EU member states to improve the quality of natural water bodies, in particular, groundwater.

REACH

As soon as a material 'ceases to be waste' (reached the EoW status), REACH requirements apply in principle in the same way as to any other material, with a number of exceptions granted conditionally. This is because requirement c in Article 6 of the WFD states, that the substance or article fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products, where the REACH Regulation is part of. The guidance on waste and recovered substances (ECHA, 2010) is helpful in applying the REACH requirements for materials with an EoW status.

The REACH Regulation makes a distinction between substances, mixtures and articles. Article 3 of the REACH Regulation defines an article as 'an object which, during production, is given a special shape, surface or design which determines its function to a greater degree than its chemical composition'. This implies that the shape, surface or design must be deliberately determined and given during a production step. The stony aggregates from C&D waste can be defined as articles when specific requirements about shape and function are stated in advance (for instance compliance to an EN standard). In that case it may be exempted from registration under REACH. Plastic aggregates for example are not articles but substances (or mixtures) because shape and function are subordinate.

When a material contains compounds that are listed in Annex XIV and Candidate list of the REACH Regulation (substances of very high concern; SVHC), it needs a REACH authorisation (temporary exception on the prohibition) to bring it on the market. Therefore, the supplier has to provide the name of the substance and all relevant safety information about this substance available to him to the recipients of this article (Article 33 of the REACH Regulation). Besides that, other restrictions can be applicable for SVHC in articles that can limit specific applications (Annex XVII). The request for an authorisation is expensive, which could be a problem for recycling companies. Next to that, the SVHC list is growing and the administrative burdens are not being reduced, but will rather be increasing.

Recovered aggregates

Following the guidance on waste and recovered substances (ECHA, 2010), recovered aggregates from construction consists of concrete, natural stones, masonry, ceramics (for example roofing tiles) and/or asphalt would be considered as articles. When the recovered aggregates have applications in civil engineering works, roads and railway ballast, the main function is to provide stability and resistance to degradation/fragmentation. In this case, the shape, surface or design is more important than the chemical composition. Therefore, it is required that the shape, surface or design of the material is deliberately determined and given during its production (for instance in order to meet certain recognized aggregated standards such as EN 12620, 13043 or 13242). More specific, particles from aggregates from C&D waste are produced with specific shape and surface characteristics depending on their application, for example, in asphalt pavements. The shape of such a particle is described using the ratio of the longest and smallest dimension of the particle. EN Standards 933-3 and

933-4, for instance, describe methods to determine the shape of such particles. The surface of such a particle is defined by its micro and macro-rugosity (that is variations in the height of a surface at different scales), which are measured as described by the EN Standards 1097-8 and 933-5 respectively. The essential chemical properties are restricted to a maximum of allowed solubility - if the aggregate is soluble it cannot fulfil its function – and are less important than the shape and surface. These particles are therefore considered to be articles according to the article definition under REACH.

The Dutch policy for stony materials is aimed at limiting the emission of substances, based on leaching, while the REACH Regulation and the WFD are based on composition. A stony article with SVHCs can be considered 'safe' during use (based on leaching, EoW and REACH), but when becoming waste, it could be classified as 'hazardous waste' (WFD and CLP) based on composition, with all associated restrictions (while the article itself has not changed). For example, following the EoW regulation it is not allowed in the Netherlands to use hazardous waste to process stony granulate. A chain approach for EoW is still important to prevent problems in a later stadium. The Dutch policy is that recycling must be stimulated if the SVHCs do not leach significantly. This is a sound direction, but not all SVHCs from the list are already measured in the materials. Extra requirements will be needed to follow the products for which the recycled material is used. The EU seems to want to go the same direction, but the EU policy is still in development.

6

Conclusions

The revised Waste Framework Directive (WFD) contains provisions to define End of Waste (EoW) criteria that provide a high level of environmental protection and an economic benefit. Developments have started on both European and national levels for a variety of materials.

The aim of this report was to study the consistency of the EoW criteria among different European countries. In the Netherlands there is one regulation with EoW criteria, specific for construction and demolition waste. Comparable regulations for inert aggregates are available for United Kingdom, France and Austria. Therefore, the EoW criteria for construction and demolition waste (inert aggregates) among the four countries are compared in this report. Because the national regulations are based on the criteria of Article 6 of the EU WFD, these regulations are generally closely related with regard to purpose and quality aspects. However, there are also several differences in the scope of materials, quality criteria and assessment methods as summarised below. Besides that, an overview is given of other national EoW regulations within the EU member states (Chapter 4). The consequences for other legislations, that is REACH, are also addressed (Chapter 5).

Inert waste: waste from concrete, bricks, tiles and ceramics (C&D waste)

There are quite a few differences in input (waste) materials among the member states, but construction and demolition waste, to be more specific, waste from concrete, bricks, tiles and ceramics (scope of the Dutch EoW regulation) is considered as input materials for recycling aggregates in all four member states. The comparison of materials (Waste catalogue codes) indicates that other member states incorporate more categories of aggregate materials in their EoW regulations than the Netherlands. This aspect is important when considering to import 'EoW aggregates' from other member states. Export should not be a problem in relation to input materials, because all Dutch input materials are included in the EoW regulation of United Kingdom, France and Austria.

Quality criteria: total composition and leaching criteria

The comparison among the four member states regarding recycling granulates also shows clearly that there are substantial differences in the parameters to be analysed.

The results indicate that the list of parameters for total composition is quite different for the four countries and this implies that the import/export of these materials cannot be done, a priori, without additional requirements from member states.

The leaching limit values among the Netherlands, Austria and France have also been assessed. Generally, the leaching criteria are quite comparable and in case of substantial differences, the Dutch criteria are, for the greater part, more tolerant than the criteria of the other member states (except for Cl, SO₄ and Cu). It has to be taken into account that the criteria in the Netherlands are based on a percolation leaching test (NEN 7373) and that the other countries have used a batch leaching test (EN 12457) for estimation of criteria. In addition, a better insight in the comparability of test results from the percolation test and the batch test needs to be gained to judge the specified emission limits derived from the different test methods.

The United Kingdom has no specific leaching criteria: the Environmental Agency of the UK decides on the EoW status, which is depending on the final product and the used procedures. Furthermore, Austria has no leaching limit values for a considerable number of substances in comparison with the Netherlands. This implies that materials with the EoW status cannot be readily accepted in the Netherlands without further testing of the emission of these contaminants. When materials are exported from the Netherlands, the producers need to check whether the products meet the, mostly, lower (less tolerant) limit values in other member states.

National EoW regulations: stimulate domestic recycling

Opportunities: National EoW regulations can improve the functioning of the internal market, because waste ceases to be waste and can be used again more easily (less administrative burdens). The removal of this barrier can contribute to a higher recycling rate of materials. The EoW status also increase the possibilities of high quality secondary materials, which will be promoted by this regulation.

Challenges: At the moment, unnecessary administrative burdens are not always removed, because when the EoW status is achieved, the material may need a REACH registration (depending on the type of recovered material). It is not always clear how to deal with these regulations and, therefore, the user perception has also not yet improved.

At the moment, the differences in the national regulations lead to the disadvantage that it is only applicable for domestic transport. For import and export of recycled granulate (with EoW status) it would be proficient if there is an EU regulation. Furthermore, many EU member states do not have a regulation for EoW (yet). When there is no EoW regulation, the recycled granulate is still waste in the receiving country and the material has to fulfil the waste regulations (WFD), which implies that there is no advantage for an EoW status for the exporting country.

EU EoW regulations: stimulate European recycling

Not only the EoW regulations of single member states will increase the benefits to recycle waste streams, also the EU EoW regulations will stimulate this aim. A benefit of this EU EoW regulation is, that the EoW status is accepted in all member states, which makes transport within the EU easier and stimulates recycling within the EU. The EU EoW regulations for metal scrap, glass cullet and copper scrap are therefore a good way

to stimulate recycling and simplify this regulation procedure to create economic and environmental benefits. EU EoW regulations for other waste streams, like waste paper, biodegradable waste (compost/digestate), waste plastic, aggregates and waste-derived fuels, would increase the economic and environmental benefits to recycle those waste streams.

To conclude this study on the national EoW criteria within the EU member states, the current status of the EoW regulation is addressed.

- Improve the functioning of the internal market: yes
For the four member states who already have an EoW regulation for inert aggregates, it can improve the functioning of the internal market, because the construction and demolition waste ceases to be waste and can be used again more easily (less administrative burdens).
- Increase recycling capacity: yes
The removal of this barrier can contribute to a higher recycling rate of these materials. The same goes for other national EoW regulations within the EU member states.
- Promote higher quality of secondary materials: yes
The EoW status also increases the possibilities of high quality secondary materials, which will be promoted by this regulation.
- Remove administrative burdens: no
At the moment administrative burdens are not always removed, because when the EoW status is achieved, the administrative burden for waste registration and regulations are removed, but the material may need a REACH registration (depending on the type of recovered material), which means another administrative burden is added.
- Improve user perception: no
It is not always clear how to deal with these regulations and, therefore, also the user perception has not been improved.
- The national EoW regulations can create a European market if the exporting and importing member states have comparable (harmonised) EoW regulations. The need for harmonised EoW regulations in all member states is recommended to stimulate the European market for EoW materials and subsequently stimulating a circular economy.

The reported findings represent the state of the art of the international developments regarding EoW criteria and can be used for further policy developments. The Netherlands has achieved the first international Green Deal North Sea Resources Roundabout. This Green Deal was signed by the Netherlands, France, Flanders and the United Kingdom on 3 March 2016. Within this Green Deal, no new regulations are to be developed, rather the alignment of interpretation of existing regulations. The goal of this Green Deal is to make it easier to trade secondary resources internationally. The first focus is on recycled PVC, compost and non-ferrous metals from bottom ash. By redefining resources and make this definition suitable for all included countries, it will become easier for companies to innovate.

This report can be used as input for the discussions within the development of the Green Deal.

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Appendix A. Overview of emission criteria

Table A.1: Overview of emission criteria for the Netherlands and France.

Member state	Netherlands			France			
Class	unbound	bound	IBC ¹	Concrete ³	Mixed (1) ⁴	Mixed (2) ⁵	Mixed (3) ⁶
Unit	mg/kg dw L/S 10	E _{64d} mg/m ² L/S 10	mg/kg dw L/S 10	mg/kg dw L/S 10	mg/kg dw L/S 10	mg/kg dw L/S 10	mg/kg dw L/S 10
Parameter							
Antimony (Sb)	0.32	8.7	0.7	0.08	0.6	0.3	0.08
Arsenic (As)	0.9	260	2	0.6	0.6	0.6	0.6
Barium (Ba)	22	1500	100	25	36	25	25
Cadmium (Cd)	0.04	3.8	0.06	0.05	0.05	0.05	0.05
Chrome (Cr)	0.63	120	7	0.6	4	2	0.6
Chrome VI					1.2	0.6	
Cobalt (Co)	0.54	60	2.4				
Copper (Cu)	0.9	98	10	3	10	5	3
Mercury (Hg)	0.02	1.4	0.08	0.01	0.01	0.01	0.01
Lead (Pb)	2.3	400	8.3	0.6	0.6	0.6	0.6
Molybdenum (Mo)	1	144	15	0.6	5.6	2.8	0.6
Nickel (Ni)	0.44	81	2.1	0.5	0.5	0.5	0.5
Selenium (Se)	0.15	4.8	2	0.1	0.5	0.4	0.1
Tin (Sn)	0.4	50	2.3				
Vanadium (V)	1.8	320	20				
Zinc (Zn)	4.5	800	14	5	5	5	5
Bromide (Br)	20	670	34				
Chloride (Cl)	616	110,000	8,800	1,000	10,000	5,000	1,000
Fluoride (F)	55	2,500	1,500	13	60	30	13
Sulfate (SO ₄)	1,730	165,000	20,000	1,300	10,000	5,000	1,300
DOC							
Phenol							

¹ Isolation, management and control

² Waste Acceptance Criteria

³ Concrete family, for type 1, 2 and 3 road building use

⁴ Mixed family, for type 1 road building use

⁵ Mixed family, for type 2 road building use

⁶ Mixed family, for type 3 road building use

Table A.2: Overview of emission criteria for Austria.

Member state	Austria						
Class	U-A ¹	U-B ²	H-B ³	B-B ⁴	B-C ⁵	B-D ⁶	D ⁷
Unit	mg/kg dw L/S 10						
Parameter							
Antimony (Sb)							
Arsenic (As)							
Barium (Ba)							20
Cadmium (Cd)							0.040
Chrome (Cr)	0.30	1.0	1.0	1.0	1.0	1.0	0.30
Cobalt (Co)							1.0
Copper (Cu)	0.60	2.0	2.0	2.0	2.0	2.0	
Mercury (Hg)							
Lead (Pb)							
Molybdenum (Mo)	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Nickel (Ni)	0.40	0.60	0.60	0.60	0.60	0.60	
Selenium (Se)							
Tin (Sn)							
Vanadium (V)	0.50	0.50	0.50	0.50	0.50	1.0	1.0
Zinc (Zn)							
Thallium							0.10
Tungsten							1.50
Bromide (Br)							
Chloride (Cl)	800	800	800	800	800	800	
Fluoride (F)	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Sulfate (SO ₄)	2,500	4,000		4,000	4,000	4,000	
Ammonium-N	4.0	8.0	8.0	8.0	8.0	8.0	
Nitrate-N	100	130		130	130	130	
Nitrite-N	1.0	2.0		2.0	2.0	2.0	
TOC	100	200	200				

¹ Aggregates for unbound and hydraulically or bituminously bound use

² Aggregates for unbound and hydraulically or bituminously bound use

³ Aggregates exclusively for the manufacture of concrete of strength class C12/15

⁴ Aggregates (in particular excavated asphalt) exclusively for the manufacture of asphalt mix

⁵ Aggregates (in particular excavated asphalt) exclusively for the manufacture of asphalt mix

⁶ Aggregates (especially excavated asphalt, including with elements of steel mill slag) exclusively for the manufacture of asphalt mix

⁷ Aggregates from steel mill slag directly from production exclusively for the manufacture of asphalt mix

Table A.3: Total content criteria for The Netherlands and France.

Member State	Netherlands	France					
Class	Construction material	CONCRETE ³	MIXED (1) ⁴	MIXED (2) ⁵	MIXED (3) ⁶	ASPHALT (1) ¹⁴	ASPHALT ¹⁵
Parameter	Unit	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw
Benzene	1						
Ethylbenzene	1.25						
Toluene	1.25						
Xylenes (sum)	1.25						
BTEX			6	6	6		
Phenol	1.25						
Naphthalene	5						
Phenanthrene	20						
Anthracene	10						
Fluoranthene	35						
Chrysene	10						
Benzo(a)anthracene	40						
Benzo(a)pyrene	10						
Benzo(k)fluoranthene	40						
Indeno(1,2,3 cd)perylene	40						
Benzo(ghi)perylene	40						
∑16PAH (EPA)	50*		50/500	50	50	50/500	50
PCB (sum)	0.5		1	1	1		
Mineral oil	500						
Asbestos	100						
Hydrocarbons (C10-C40)		500					
Hydrocarbons (C10-C21)			300	300	300	300	300
TOC			30,000/ 60,000	30,000/ 60,000	30,000/ 60,000		

* ∑10PAH

Table A.4: Total content criteria for Austria.

Member State	Austria						
Class	U-A ⁷	U-B ⁸	H-B ⁹	B-B ¹⁰	B-C ¹¹	B-D ¹²	D ¹³
Unit	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg dw	mg/kg
Parameter	dw	dw	dw	dw	dw		dw
Lead	100	100	100	100	100	500	
Chrome	90	90	90	90	90	2,500	2,500
Copper	90	90	90	90	90	500	
Nickel	60	60	60	60	60	500	
Mercury	0.70	0.70	0.70	0.70	0.70	0.70	
Zinc	450	450	450	450	450	450	
Cadmium							1.10
Molybdenum							50
Thallium							50
Tungsten							450
Σ16PAH (EPA)	12.0	20	20	20	300	20/300	



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