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HEAVY METALS AND ORGANIC COMPOUNDS FROM WASTES USED AS ORGANIC FERTILISERS

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ANNEX 2

COMPOST QUALITY DEFINITION – LEGISLATION AND STANDARDS

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ANNEX 2 – COMPOST QUALITY DEFINITION – LEGISLATION AND STANDARDS

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1 GENERAL ASPECTS OF COMPOST CLASSIFICATION

It is a common peculiarity of legislation and standards for waste products designated as organic soil amendment or fertiliser that the main focus lies on restrictions for the use in consideration of environmental and soil conservation aspects. Legal regulations are usually set up for harmful elements (PTEs and organic pollutants respectively) in the compost, limit values for heavy metals being the most obvious example.

In addition fertiliser laws and ordinances as well as obligatory programmes in conformity with the Nitrates Directive or programmes on limiting the phosphorus load in agricultural soils require a limitation of nutrient inputs at the level of annual demand.

If good agricultural practice follows the principle of balancing nutrient supply according to the actual needs of the crop (or crop rotation) the load of potential pollutants as accompanying (micro)constituents might be restricted by the individual concentration.

Beside undesired environmental impacts of potential pollutants most statutory as well as voluntary standards also focus on potential risks for the consumer and the intended crop system. Parameters with minimum requirements and corresponding numeric limitations are:

- Electrical conductivity (salt content)
- Organic matter content
- Impurities (glass, metals, plastics)
- Maturity (e.g. self heating test)
- Plant toxicity (bioassays via growth test with cress or barley etc.)

Most important, where products derived from waste are authorised to be marketed standardised declaration and labelling are obligatory tools in order to ensure correct information on the proper (sustainable) use of the organic fertiliser. As long as the use of (processed) waste material such as sludge and compost is subject to waste legislation, the control instruments may as well cover the rules of application (this is entirely true for sewage sludge). This does not apply if the waste derived material is regulated under the product regime as it is already the case in Austria and Italy for compost.

These principal conditions and the progress of implementation of separate collection and composting systems have to be considered when viewing the legal framework in the area of compost production and use in European countries.

Up to now comprehensive regulation of all types of fertiliser with a unique approach for limiting the concentration and load of pollutants to the soil are still missing. The first national approach towards soil protection legislation encompassing all types of activities, which may entail adverse effects on the soil, can be found in Germany Soil Protection Act (BBSchG, 1998). The Soil Protection Ordinance (BBSchV, 1999) which was enacted on the basis of this law, defines precautionary, trigger and intervention values for soils and maximum loads of heavy metals if precautionary values are exceeded

on agricultural land. Still this soil protection legislation is just a component of fertiliser, biowaste and water conservation and sewage sludge regulations which determine minimum material qualities and limitations for the use of (waste derived) fertiliser. A similar situation is to be found in Switzerland where the Ordinance on the Contamination of Soils (Anonymous, 1998) defines guide, trigger and remediation values for soils under diverse use and is supplemented by the Decree on Hazardous Substances (Anonymous, 1986). In Denmark sewage sludge and compost are covered by the same regulation, in which limit values for the products as well for the soil are defined (Ministry of Environment and Energy, 1996.).

In contrast a multitude of individual regulations for sewage sludge, compost, mineral and organic fertiliser and manure respectively are to be found in the majority of MSt. Very often the application rules are subject to the provincial jurisdiction. Therefore widespread strategies even within one country is a common reality. Consequently maximum admissible loads distributed on land vary considerably.

Good knowledge of the differentiated quality of the various compost types (biowaste, mixed solid waste, sewage sludge etc.) led in some MSt to classification system of composts with the following categories:

Table A2- 1: Existing classification of composts in statutory and voluntary standards

Category that is classified	Country
heavy metal contents	Austria, Canada, Germany, Netherlands, Spain, Sweden, the Netherlands, Canada and USA
type of raw material	Austria, Belgium, Denmark, Germany, Italy, Spain and Sweden
degree of maturity	Australia, Germany, Luxembourg and Spain (and to some degree in Canada)
compost types based on application	Austria and Germany

From this and Table A2- 2 it can be seen that some countries opted for a complex system, integrating levels of quality (PTE) classes with categories of admissible input materials and differentiated restriction of application areas in order to fulfil the general principle of “*the recycling measure has to be beneficial to the environment ...*”.

Table A2- 2: Number of classes in compost standards and rationale for differentiation (taken from Hogg et al., 2002)

	Number of Classes	Description of Classes
Austria	Three	Class A+ (top quality; limit values taken from Council Regulation (EEC) No.2092/91 on organic farming) Class A (high quality; suitable for use in agriculture) Class B (minimum quality; suitable for non-agricultural use)
Belgium <i>Flanders</i> <i>Brussels</i>	One (Min of Ag) Three (Vlaco, voluntary) One	Bio-compost (compost from source-separated biowaste) Humotex (compost from aerobically composted digestion residuals) Green waste (compost from source-separated garden waste) Source separated biowaste and green waste.
Denmark	One	Product standard
Finland	One	Product standard
France	One (N FU 44 051) Two (Compost Urbain)	Two (Compost Urbain - standards with same limit values for heavy metals and different standards for physical contaminants - Class A and B) – voluntary marketing standards
Germany	Two	Two classes defined with respect to heavy metals
Greece	One	Only mixed waste composting
Ireland	Two	
Italy	One set of limit values Two categories of soil improver	Composted green soil improver (“ <i>ammendante compostato verde</i> ”; compost only from vegetable waste); and composted mixed soil improver (“ <i>ammendante compostato misto</i> ” compost from vegetable waste, plus sewage sludge and/or food leftovers, etc.) (differentiated by organic carbon content, C/N ration and humic /fulvic acid content)
Luxembourg	Two	As German RAL standard – also differentiation between fresh and mature compost
Netherlands	Two	Limit values distinguish between very good compost and good compost (through heavy metals).
Portugal	One standard ‘assumed’ (no law)	Through heavy metals
Spain	One in Spain	Catalonia classes defined through reference to heavy metals

	Number of Classes	Description of Classes
	Two in Catalonia	
Sweden	One	Product standard
UK	One	Product standard
Australia	One class of PTE limits Four classes	Four different products defined by the various limit values in the standard. These four products are divided into the two classes, 'composted product' and 'pasteurised product', each of which contains two sub-classes, 'soil conditioners and fine mulch', and 'mulch'.
New Zealand	One	Product standard
Canada	Canadian Food Inspection Agency (AAFC): 1 class Canadian Council of Ministers of the Environment: 2 classes (A; B) Bureau de normalisation du Quebec: 3 classes (AA; A; B)	The AAFC recognizes only one class of compost, reflective of product safety criteria. It is based on the limits of CCME's Category B and BNQ's Type B compost for trace elements. It reflects the requirements for product maturity, absence of pathogen content and the limits on the presence of sharp objects as part of the foreign matter criteria. Within the CCME Guideline, two compost categories have been established (Category A; and Category B). The difference between the two categories reflects limits set for trace element concentrations. Category A compost may be used for all types of applications: on agricultural lands, in residential gardens, in horticultural operations, in nurseries or other enterprises. Category A criteria for trace elements are achievable using source separated municipal solid waste feedstock. Category B compost has restricted use. The controls established for its use are determined by each province or territory individually. Under the BNQ Standard, compost may be classified in three ways (Type AA; Type A; and Type B). The requirements for Type B compost are considered to be the minimum necessary to obtain good compost. Compost classified as Types AA and A is of higher quality. Total organic matter content and foreign matter content are the distinguishing factors between the three types. Trace element content is the classification feature that differentiates Type AA and Type A compost from that of Type B compost.
USA	One	Product standard (bio-solids)

2 SURVEY ON REGULATIONS OF COMPOST QUALITY

Statutory standards for compost quality are implemented in 9 of the 15 EU MS. In Portugal, Greece and Ireland not even voluntary standards are established. Table A2- 3 highlights the national regulations as far as waste derived fertilisers and compost are concerned. Specific sewage sludge regulations are not included.

Table A2- 3: Statutory regulations concerning the compost quality – BWC / GC / SSC / MSWC / MBTC (current and proposed)

	Legal regulations for the compost quality
Austria	Compost Ordinance (FLG II Nr. 292/2001) → all types of compost
Belgium	Royal Decree (Royal Decree (<i>Koninklijk Besluit 07.01.1998</i>)) with additions from March 1990; VLAREA, the Flemish Regulation on Behalf of Waste Prevention and Waste Management. → BWC/GC
Denmark	<ul style="list-style-type: none"> • Statutory Order No. 49 of „Application of Waste Products for Agricultural Purposes” (Ministry of Environment and Energy, 1996.) • Statutory Order regarding fertilisers and soil improvers No. 612 (Ministry of Agriculture and Fishery, 1996)
Finland	<ul style="list-style-type: none"> • Decisions of the Ministry of Agriculture and Forestry (46/94) • Fertiliser Act (232/93)
France	Standard: NF Compost Urbain, NF U 44 051, in revision (MSW compost, soil improvers, manure, bark compost etc)
Germany	Biowaste Ordinance (Bioabfallverordnung – BioAbfV 21.9.1998; BGBl. I Nr.65)
Greece	Regulation on MSW compost and sewage sludge. JMD 114218/97 (or ΦEK 1016B/17-11-1997) → MSWC/SSC
Ireland	Licensing according to waste management act
Italy	<ul style="list-style-type: none"> • Law on Fertilisers (L 748/84) as modified by Decree 27 March 1998 → BWC/GC/SSC • Technical regulation, DCI 27/07/84 → MSWC/MBTC • Draft Decree on the use of MBT (compost) based on Article 18 of Decree 22/97
Luxembourg	Licensing
The Netherlands	BOOM-decree 20 Nov 1991, Stb.613 („Decision on quality and use of other organic fertilisers”) → BWC/GC
Portugal	None for compost; regulation for sewage sludge only (Decreto Lei nr. 446/91)
Spain	<ul style="list-style-type: none"> • Law 6/93, 15 July, regulating wastes • Ordinance on Fertilisers and Related Products, 28 May 1998 (Orden 28/V/1998 sobre Fertilizantes y Afines) • Draft of Standard on Composting & Compost (national) • Draft Decree on Compost Quality (Catalonia)
Sweden	Voluntary standards only
Switzerland	Decree on hazardous substances (Verordnung über umweltgefährdende Stoffe Nr. 814.013; 9. Juni 1986); under revision (draft from 01.05.02)
UK	Voluntary standards only (Compost Association)

3 LIMITATION OF PTEs IN COMPOST

Within the technical report elaborated by CEN/TC 223 'Soil improvers and growing media' (CEN TC 223, 1999) the difficulties to agree to a unique approach to limiting heavy metals for specified products became evident. This is proved by looking at the national regulations in Europe and overseas (Table A2- 4). The CEN Technical report discusses the problem as follows:

„The way in which limit values for the levels of PTEs (that are considered to have acceptable risk) are determined, can vary according to the viewpoint adopted. Thus there are a number of different protocols that can be adopted to establish limit values with respect to the safety of the product. These can be simplified into the following:

- *Risk assessment based on No Observable Adverse Effect Levels (NOAEL)*
- *Precautionary limitation or No Net Degradation (NND)*
- *Best available technology*
- *Hybrid systems“*

Consequences and dis/advantages of either the one or the other concept followed in EU MSt are discussed in chapter 8.

Consequently the level of heavy metals admissible for organic waste composts and the yearly load per area unit is correlated with the status of implementation of source separated collection of organic wastes.

Three elements constitute the system of risk management and precaution strategies for the distribution of heavy metals in the environment through waste materials considered as soil improvers or organic fertiliser:

- limitation of the concentration of heavy metals in the product
- limitation of the yearly load of heavy metals to the land ($\text{g}\cdot\text{ha}^{-1}\cdot\text{y}^{-1}$) sometimes combined with restriction of the admissible dosage of dry matter compost per ha and year
- the establishment of maximum heavy metal concentration in soils, either for agricultural soils in general or valid only for sites where compost or sludge is applied.

In Table A2- 4 heavy metal limit values of statutory and voluntary standards are assembled.

Table A2- 4: Heavy metal limits for European compost standards (revised figures from Amlinger, 1999 and Hogg et al., 2002)

Country	Regulation	Type of standard	Cd	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn	As
Austria	Comp.ord.:Class A+ (organic farming)	statutory decree	0.7	70	-	70	0.4	25	45	200	-
	Comp.ord.:Class A (agric.; hobby gardening)		1	70	-	150	0,7	60	120	500	-
	Comp.ord.:Qu-Class B limit value (landscaping; reclam.) (guide value)*		3	250	-	500 (400)	3	100	200	1,800 (1,200)	-
Belgium	Royal Decree, 07.01.1998	statutory decree	1,5	70	-	90	1	20	120	300	-
Denmark	Statutory Order Nr.49; Compost after 01 06 2000	statutory decree	0.8	-	-	1,000	0.8	30	120/60 for priv. gardens	4,000	25
Finland	Decisions of the Ministry of Agriculture and Forestry (46/94)	statutory decree	3	-	-	600	2	100	150	1,500	50
France	NF COMPOST URBAIN	standard	3				8	200	800		
Germany	Quality assurance RAL GZ - compost /digestion	voluntary QAS	1.5	100	-	100	1	50	150	400	-
	Bio waste ordinance (Class I)	statutory decree	1	70	-	70	0.7	35	100	300	-
	Bio waste ordinance (Class II)		1.5	100	-	100	1	50	150	400	-
Greece I), (x)	-specifications framework and general programmes for solid waste management	statutory decree	10	510	10	500	5	200	500	2,000	15
Ireland	Licensing of treatment plants as agreed with EPA	voluntary	1.5	100	-	100	1	50	150	350	15
	(Class I)	voluntary	1	100	-	100	1	50	100	200	
	(Class II)	voluntary	1.5	150	-	150	1	75	150	400	
Italy	Technical regulation, DCI 27/07/84 (MSWC)	statutory decree	10	500	10	600	10	200	500	2,500	10
	Draft Decree on the use of MBTC 1 st quality (land reclamation)	DRAFT → statutory	3	-	3	300	3	100	280	1,000	-

Country	Regulation	Type of standard	Cd	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn	As
	Law on fertilizers (L 748/84; amd: 03/98) BWC/GC/SSC	statutory decree	1.5	-	0.5	150	1.5	50	140	500	
Luxembourg	licensing for plants		1.5	100	-	100	1	50	150	400	-
Netherlands	BOOM Compost	statutory decree	1	50	-	60	0.3	20	100	200	15
	BOOM very clean Compost		0.7	50	-	25	0.2	10	65	75	5
Portugal	Decree on sludge (limit values utilised also for MSW)	statutory decree	20	1,000		1,000	16	300	750	2,500	-
Spain	B.O.E.n'm.131.2 June 1998	statutory decree	10	400	-	450	7	120	300	1,100	-
	Spanish draft on composting Class AA	DRAFT statutory decree	2	250	-	300	2	100	150	400	-
	(Stabilised Biowaste) Class A		5	400	-	450	5	120	300	1,100	-
	Catalonia draft on composting Class A		2	100	0	100	1	60	150	400	-
	(Stabilised Biowaste) Class B		3	250	0	500	3	100	300	1,000	-
Sweden	Guideline values of QAS	voluntary	1	100	-	100	1	50	100	300	
Switzerland	Verordnung über umweltgefährdende Stoffe Nr. 814.013; 9. Juni 1986; rev.. 28.12.01)	statutory decree	1	100	-	100	1	30	120	400	-
UK	UKROFS fertil.org.farming, 'Composted household waste'	statutory (EC Reg. 2092/91)	0.7	70	0	70	0.4	25	45	200	-
	Composting Association Quality Label	voluntary	1.5	100	-	200	1	50	150	400	-
EU ECO Label	Soilimprovers and growing media	voluntary	1	100	-	100	1	50	100	300	10
(EC Reg. 2092/91)	Compost from source separated Biowaste	statutory	0.7	70	-	70	0.4	25	45	200	-

Table 3-7: Heavy metal limits for European compost standards (continued)

Country	Regulation	Type of standard	Cd	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn	As
Canada			20	-	-	-	5	180	500	1,850	75
USA	EPA CFR40/503 Sludge Rule		39	no ceiling	-	1,500	17	420	300	2,800	41
	NY State DEC* Class I		10	100	-	1,000	10	200	250	2,500	-
	WA State Dept of Ecology, Grade A		10	600	-	750	8	210	150	1,400	20
	WA State Dept of Ecology, Grade AA		39	1,200	-	1,500	17	420	300	2,800	20
	Texas TNRCC Grade 1 Compost		16	180	-	1,020	11	160	300	2,190	10
	Texas TNRCC Grade 2 Compost		39	1,200	-	1,500	17	420	300	2,800	41
	Rodale Organic Seal of Compost Quality		4	100	-	300	0.5	50	150	400	10
New Zealand			15	1,000	-	1,000	10	200	600	2,000	-

* if exceeded to be marked within labelling

Table A2- 5: Maximum. Minimum and mean limit values of PTEs for composts in Europe

Limit values for Compost from source separation (BWC & GC)									
	Cd	Cr	CrVI	Cu	Hg	Ni	Pb	Zn	As
	<i>mg kg⁻¹ d.m.</i>								
min	0.7	50	0	25	0.2	10	45	75	5
max	3	250	3	600 (1,000)*	3	100	280	1,500 (4,000)*	50
mean	1.4	93	0.9	143 (184)*	1.0	47	121	416 (587)*	23
max/min	4.3	5.0		24.0	15.0	10.0	6.2	20.0	10.0
Limit values for MSW and MBT Composts)									
	<i>mg kg⁻¹ d.m.</i>								
min	3	250	0	450	3	100	200	1,000	10
max	20	1,000	10	1,000	16	300	800	4,000	25
mean	8.0	473	6.7	625	7.1	168	456	2,000	17
max/min	6.7	4.0		2.2	5.3	3.0	4.0	4.0	2.5

* Limits for Cu=1,000 and Zn=4,000 mg kg⁻¹d.m. are stemming from the Danish *Statutory Order on Application of Waste Products for Agricultural Purposes* where sewage sludge is covered as well as compost. Together with the fact that Cu and Zn are addressed as essential nutrients This explains the extremely high thresholds .

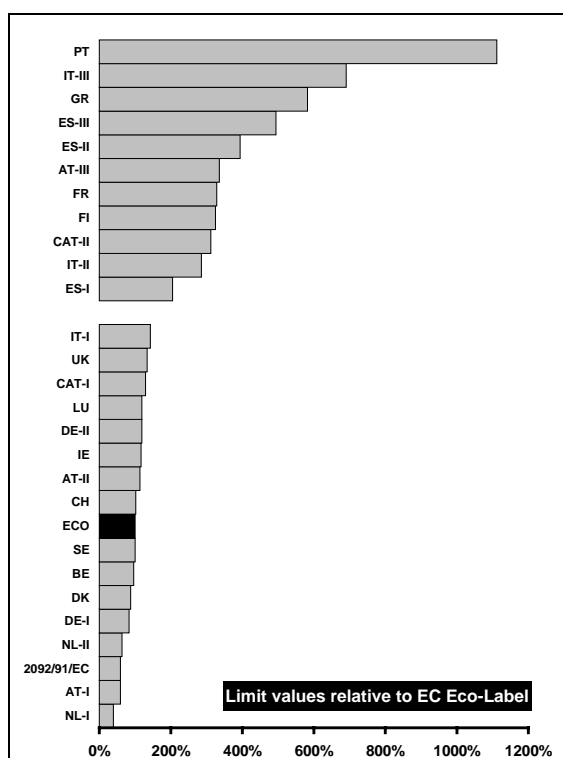


Fig.A- 1: PTE limit values for composts in European countries [mean percentage relative to threshold values of the EC Eco-label for soil improver].

Table A2- 5 distinguishes between regulations which already are based on a quality level as a result of source separation of organic waste and PTE limits for materials and composts which stem from MSW, sewage sludge or MBT materials. Within the regulations for biowaste we still find a considerable variation. The difference between maximum and minimum thresholds is lowest for Cd and highest for Cu with the factor 4.3 and 24 (!) respectively.

Fig.A- 1 gives a comparative survey on heavy metal limit and guide values for composts in European countries expressed as relative mean limits as compared to the maximum concentration of the EC Eco-Label for soil improver (= 100 %). Countries with more than one compost category or quality class referring to PTE thresholds are indicated with 'I / II / III'.

It becomes evident, that in those countries where source separation for organic household waste has not been implemented so far, concentration limits for

compost are still orientated at MSW compost or sewage sludge regulations.

The presumably most sophisticated model was implemented in the Austrian Compost Ordinance. We summarise the classification system here as an example.

The 3 classes are defined by 3 heavy metal limits:

The ordinance defines three different quality classes for compost based on the contaminant content (see attached details):

- **Class A+** (top quality; limit values taken from Council Regulation (EEC) No. 2092/91 on organic farming - see below)
- **Class A** (high quality; suitable for use in agriculture)
- **Class B** (minimum quality; suitable for non-agricultural use)

Due to the not always understandable, extremely low permitted values for individual parameters (e.g. nickel), it is very difficult to achieve **Class A+** standards. However, this is the class, which must be achieved by farmers running organic farms in keeping with *Council Regulation (EEC) No. 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs*.

Compost produced from separately collected biowaste generally achieves **Class A quality**. **Class B quality** can be achieved by the use of suitable sewage sludge.

Table A2- 6: Maximum heavy metals concentration for composts and sewage sludge as input material

	Cd	Cr _{tot}	Cu	Hg	Ni	Pb	Zn
COMPOST							
class A+ → <i>org. farming</i>	0.7	70	70	0.4	25	45	200
class.A → <i>agriculture</i>	1	70	150	0.7	60	120	500
class.B → <i>land reclamation</i> .	3	250	400/ 500*	3	100	200	1,200/ 1,800*
SEWAGE SLUDGE							
for 'quality sludge compost'	2.0	70	300	2.0	60	100	1,200
for 'compost'	3.0	300	500	5.0	100	200	2,000

* guide / limit value for Cu and Zn; if the guide value in the compost is exceeded the concentration has to be indicated in the labelling

Basically compost must be labelled as "**Compost**".

In order to mark composts processed from high quality source materials, the ordinance allows the following terms:

- **Quality Compost**, suitable for use according to *Council Regulation (EEC) No. 2092/91 'on organic production of agricultural products* and indications referring thereto on agricultural products and foodstuffs (compost must be at least class A+ quality and produced from separately collected organic waste)

- **Quality Compost** (compost of at least class A quality, produced from separately collected organic waste)
- **Quality Sewage Sludge Compost** (compost of at least class A quality, produced from good quality sewage sludge and separately collected organic waste)
- **Bark Compost** (produced exclusively from bark)

Compost derived from non-hazardous household waste and similar commercial waste is to be labelled as **Municipal Solid Waste Compost**. The areas in which municipal solid waste compost may be used are restricted (landfill surface cover or biofilter). Municipal solid waste compost cannot be marketed freely but must be transferred from the producer directly to the user.

The admissible compost *designation in the labelling* and the area where the compost may be applied depends on the category of input materials used as well as on the applicable quality class (heavy metals). The basic system is shown in Table A2- 7.

Table A2- 7: System of compost indication, quality classes, input category and area of application

Input Category		Quality Class (heavy metal class)		
		A+	A	B
<u>Only</u> Category 1 'Biowaste'	<i>Designation</i>	Quality Compost <i>"suitable for organic farming acc. To 2092/91 EEC"</i>	Quality Compost	Compost
	<i>Application area**</i>	any	agriculture <i>organic farming</i> [°]	landscaping <i>agriculture</i> [°]
Category 1 and 2 (incl. sewage sludge)	<i>Designation</i>	Compost or Quality - Sewage Sludge-Compost *	Compost or Quality - Sewage Sludge-Compost *	Compost
	<i>Application area**</i>	agriculture <i>organic farming</i> [°]	agriculture <i>organic farming</i> [°]	landscaping <i>agriculture</i> [°]
<u>Only</u> Category 3 MSW Compost	<i>Designation</i>	MSW Compost	MSW Compost	MSW Compost
	<i>Application area**</i>	reclamation of landfill sites; biofilter; <i>agriculture</i>		
<u>Only</u> Bark	<i>Designation</i>	Bark Compost	Bark Compost	Bark Compost
	<i>Application area**</i>	any	agriculture <i>organic farming</i> [°]	landscaping <i>agriculture</i> [°]

*...The designation QUALITY-SEWAGE SLUDGE COMPOST is admissible, if the lower heavy metal limits for sludge of Table A2- 6 is achieved

**...only those application areas are indicated which require the highest degree of quality

° crossed out applications are not permitted to be used for the indicated compost qualities

Moreover the general **application areas** (*agriculture, landscaping, reclamation on landfill sites, biofilter and constituents in substrates/manufactured soils*) are split into several **application cases** for which specific restrictions for the use may apply

All other material is classified as waste and remains waste whatever is done with it (and it is subject to landfill taxes etc.).

4 RESTRICTION FOR THE USE OF COMPOST / LIMITATION OF PTE INPUT TO THE SOIL

As stated above utilisation restrictions play an essential role in most of statutory regulations especially for agricultural applications. As far as PTEs are concerned we have to distinguish between

- direct load limitation ($\text{g}\cdot\text{ha}^{-1}\cdot\text{y}^{-1}$), in most cases calculated on a basis of 2 to 10 years
- restriction of the admissible dosage of dry matter compost per ha and year and
- restriction according to a maximum nutrient supply (phosphorus or nitrogen) of the agricultural crops

Table A2- 8 reviews the restrictions and regulations for the use of composts and stabilised organic wastes from MSW or MBT material. Table A2- 9 summarises the maximum load of PTEs to the soil in European standards and regulations.

Table A2- 8: Regulatory systems of restrictions for the use of composts

Country	Type of dosage or load restriction
Austria	<ul style="list-style-type: none"> • agriculture: $8 \text{ t d.m. ha}^{-1}\text{y}^{-1}$ on a 5 year basis • land reclamation: 400 or 200 t d.m. $\text{ha}^{-1}\text{y}^{-1}$ within 10 years depending on quality class • non food regular application: 20 or 40 t d.m. $\text{ha}^{-1}\text{y}^{-1}$ within 3 years dep. on quality class
Belgium	<ul style="list-style-type: none"> • fixed maximum heavy metal load • regulations with respect to manure application based on N and P content, Manure Action Programme (MAP).
Denmark	<ul style="list-style-type: none"> • food production: $7 \text{ t d.m. ha}^{-1}\text{y}^{-1}$ on a 10 year basis • non food: $15 \text{ t d.m. ha}^{-1}\text{y}^{-1}$ on a 10 year basis • restriction of nitrogen and phosphorus to $210 \text{ kg ha}^{-1}\text{y}^{-1}$ and $30 \text{ kg ha}^{-1}\text{y}^{-1}$, respectively
Finland	<ul style="list-style-type: none"> • fixed maximum heavy metal load (sewage sludge regulation)
France	<ul style="list-style-type: none"> • fixed maximum heavy metal load (compost standard)
Germany	<ul style="list-style-type: none"> • agriculture: 10 or $6.7 \text{ t d.m. ha}^{-1}\text{y}^{-1}$ on a 3 year basis
Greece	<ul style="list-style-type: none"> • no regulation
Ireland	<ul style="list-style-type: none"> • no regulation
Italy	<ul style="list-style-type: none"> • food production: fixed maximum heavy metal load (Techn reg. DCI 27/07/84) • land reclamation: $100 \text{ t d.m. ha}^{-1}$ or up to 300 t ha^{-1} ha and more where supported by risk assessments
Luxembourg	<ul style="list-style-type: none"> • no specific regulations; advise (voluntary): $15 \text{ t d.m. ha}^{-1}\text{y}^{-1}$
The Netherlands	<ul style="list-style-type: none"> • agriculture: <i>standard compost</i> / <u>arable land</u>: $6 \text{ t d.m. ha}^{-1}\text{y}^{-1}$ on a 2 year basis <u>grassland</u>: $3 \text{ t d.m. ha}^{-1}\text{y}^{-1}$ on a 2 year basis <i>very clean compost</i> max. $80 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}\text{y}^{-1}$ new strategy: balance of supply and losses of heavy metals • set-aside land: <i>standard compost</i> / <u>arable land</u>: $6 \text{ t d.m. ha}^{-1}\text{y}^{-1}$ on a 2 year basis <i>very clean compost</i> max. $20 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}\text{y}^{-1}$
Portugal	<ul style="list-style-type: none"> • fixed maximum heavy metal load (sewage sludge regulation)

Spain	<ul style="list-style-type: none"> fixed maximum heavy metal load on a 10 year basis
Sweden	<ul style="list-style-type: none"> fixed maximum heavy metal load (sewage sludge regulation) agriculture: restriction of nitrogen and phosphorus to 150 kg ha⁻¹y⁻¹ and 22 – 35 kg ha⁻¹y⁻¹, respectively
Switzerland	<ul style="list-style-type: none"> agriculture: 8,3 t d.m. ha⁻¹y⁻¹ on a 3 year basis
UK	<ul style="list-style-type: none"> no specific regulations; fixed maximum heavy metal load (sewage sludge regulation) voluntary Code of Good Agricultural Practice for the Protection: limitation of nitrogen to 250 kg ha⁻¹y⁻¹ (for all types of fertiliser used)

The ranges of restrictions for the amount of compost (on dry matter basis per ha) or plant nutrients to be applied are as follows:

• quantity of compost*	agriculture / regular	3 t (pasture land) – 15 t (arable land) ha ⁻¹
	non food / regular	6.6 t – 15 t ha ⁻¹
	non food / once	100 t – 400 t ha ⁻¹
• quantity of N	agriculture / regular	150 kg – 250 kg ha ⁻¹
• quantity of P ₂ O ₅	agriculture / regular	22 kg – 80 kg ha ⁻¹
	set aside land	20 kg ha ⁻¹

* in most cases quantity differentiation is depending on quality class obtained.

Following the ongoing discussion of the use of compost in the frame of *good agricultural practice* one can realise a clear trend towards a system that ensures a balanced nutrition of the plants. This clearly focuses on the *wanted* or *beneficial effect* of compost, more than a ban of related to heavy metal loads would.

It is evident that this approach has to be based on the site-specific demands indicated by crop rotation, nutrient status, susceptibility to leaching of nutrients and mineralisation potential.

However, many of the maximum loads of PTEs to the soil defined in European standards and regulations and summarised in Table A2- 9 are stemming from traditional sewage sludge regulations or are calculated from quantitative compost limitations multiplied by heavy metal threshold values.

Table A2- 9: Admissible maximum dosage of heavy metals to the soil in European legislation and standards and the USA ($\text{g ha}^{-1} \text{y}^{-1}$)

Country		Cd	Cr _{tot}	Cr ^{VI}	Cu	Hg	Ni	Pb	Zn	As	Mo
		$[\text{g ha}^{-1} \text{y}^{-1}]$									
EC/ 'sew. sludge' *	10 y basis	0.15	3.0 ⁴⁾	-	12	0.1	3.0	15	30	-	-
Austria	sewage sludge ¹⁾	20	1,250	-	1,250	20	250	1,000	5,000	-	-
	Fertiliser Ordinance/2 y basis	10	625	-	625	10	375	625	2,500	-	-
	Comp.Ord.: agriculture/5 y basis ²⁾	8	560	-	1,200	5.6	480	960	4,000	-	-
	Comp.Ord.: land recl. Cl. A/3 y basis ²⁾	13.3	933	-	2,000	9.3	800	1,600	6,665	-	-
	Comp.Ord.: land recl. Cl. B/3 y basis ²⁾	20	1,668		3,335	20	667	1,334	12,006		
Belgium ⁷⁾	VLAREA	12	500	-	750	10	100	600	1,800	300	-
Denmark	agriculture	5.6	700		7,000	5.6	210	840	28,000	175	
	non food	12	1,500		1,500 0	12	450	1,800	60,000	375	
Finland		3	300		600	2	150	150	1,500		
	Goal for 1998	1.5				1	100				
France ³⁾	s.sludge/industr.waste	30 ^{oo}			1,500	15	300	1,500	4,500		
	pH < 6	15			1,200	12	300	900	3,000		
	Draft NF U 44 51	15	600		1,000	10	300	900	3,000	90	
Germany	sewage sludge	16	1,500	-	1,300	13	300	1500	4,100	-	-
	Bio Waste Ordinance (I) /3 y basis ²⁾	10	700	-	700	7	350	1,000	3,000		
	Bio Waste Ordinance (II) /3 y basis ²⁾	10	667	-	667	7	334	1,001	2,668		
Italy	DCI 27/07/84	15	2,000	15	3,000	15	1,000	500	10,000	100	
The Netherlands ²⁾	Compost	6	300		360	1.8	120	600	1,200	90	-
Portugal	Decree on Sludge/10 y basis	150	4,500		1,200 0	100	3,000	1,500 0	30,000		
Spain	Decr. 877/1991 ^{oo}	150	4,500		1,200	100	3,000	1,500	30,000	-	-
Sweden	SNFS 1992:2	0.75	40		300	1.5	25	25	600		-
Switzerland	StoffVo	6.2	333		2,500	12.5	208	208	5,000		-
USA ⁶⁾		1,900	-	-	75,000	850	21,000	15,000	140,000	2,000	0.9

- * Directive 86/276/EEC; average within a period of 10 years ¹⁾ Sew. Sludge Ordinance, Lower Austria (Class III)
- ²⁾ from maximum compost dosage $\text{ha}^{-1}\text{y}^{-1}$ ³⁾ max. mean load per year within a period of 10 years; $\text{Cr}+\text{Cu}+\text{Ni}+\text{Zn}$:
 $6 \text{ kg ha}^{-1}\text{y}^{-1}$ ($\text{pH} < 6.0$: 4 kg/ha.y ; Se on pasture land: 0.12 kg/ha.y)
- ⁴⁾ planed ⁵⁾ preliminary
- ⁶⁾ only for sewage sludge that exceeds "high quality" limit values for h.m.
- ⁷⁾ for secondary raw materials ^o if deficit of Cu or Zn , the addition may be max doubled
- ^{oo} $0,015 \text{ kg ha}^{-1}\text{y}^{-1}$ from 2001 ^{ooo} over a period of 10 years

When viewing the admissible loads of PTEs in European compost and legislation the local value of soil protection policy as well as the starting point of the standard set can be identified. When originating from sewage sludge regulations, where the maximum amount of sludge for the use in agriculture is low ($1.5 - 3 \text{ t d.m. ha}^{-1}\text{y}^{-1}$) in some cases maximum PTE loads are extremely low (SE and FI). In addition analytical methods used for the extraction of metals in the substrate also have to be regarded. The restrictive

limitation of total amounts of compost to be applied on land again determines the resulting metal load on the basis of maximum PTE concentrations in the product.

Even if one looks only on standards for biowaste and green waste composts the variation is enormous. The maximum value ranges from the 3.3-fold (As) to the 50-fold (Cr) of the minimum values for admissible PTE loads (see Table A2- 10).

The very high figures for Cu and Zn stemming from 1,000 and 4,000 mg kg⁻¹ d.m. limit values in Denmark mark the low consistency when comparing with the relative moderate numbers of the other metals. It is obvious that *traditional* rules originating from MSW and sludge standards show noticeable higher levels.

Table A2- 10: Minimum, maximum and mean admitted yearly loads of PTEs in European soil protection, compost and sewage sludge regulations

Compost from source separation (BWC & GC)									
	Cd	Cr	CrVI	Cu	Hg	Ni	Pb	Zn	As
	<i>mg kg⁻¹ d.m.</i>								
min	0.8	40		300	1.5	25	25	600	90
max	15.0	2,000		7,000	15.0	1,000	1,001	28,000	300
mean	8.2	609	15	1,643	7.1	293	617	5,524	151
<i>max/min</i>	<i>20</i>	<i>50</i>		<i>23</i>	<i>10</i>	<i>40</i>	<i>40</i>	<i>47</i>	<i>3.3</i>
MSW / MBT Composts / sewage sludge (BWC & GC)									
	<i>mg kg⁻¹ d.m.</i>								
min	12	933		2,000	9	450	1334	6665	
max	150	4,500		50,000	100	3,000	15,000	60,000	
mean	69	2,320		16,467	48	1,583	6947	27,734	375
<i>max/min</i>	<i>12.5</i>	<i>4.8</i>		<i>25</i>	<i>10.7</i>	<i>6.7</i>	<i>11.2</i>	<i>9</i>	

5 LIMITS FOR ORGANIC POLLUTANTS IN COMPOST

Only in two countries limit values for organic pollutants established for BWC and GC are to be found (Table A2- 11). In Germany in only one region, Baden-Württemberg, guide values for PCB and PCCD/F have been issued. After a period in the early 90ies when the occurrence of Dioxins, PCBs and other organic pollutants was discussed controversially a number of investigations have been started (Krauß et al., 1992; Krauß, 1993; Fricke and Vogtmann, 1993; Tabasaran & Sihler, 1993; Fricke and Einzmann, 1995; Krauß et al., 1995; Kumer, 1996; Zethner et al., 2001 among others). In Austria, Germany, the Netherlands and Switzerland no limit values for organic compounds are provided because of the low level that was detected in composts derived from the source-separated materials (see chapter 5).

In Austria a number of organic pollutants must only be analysed in MSWC, which in addition is restricted to the use as landfill reclamation layer and bio-filter. The Federal German Council, however, asked the German Federal Government to investigate the need for limit values for harmful organic matter before 31st December 2002. It is notable also that Denmark, with its high rate of composting of garden waste, has tight legislation concerning pesticides and recently implemented a ban on the use of garden pesticides.

Denmark sets quality criteria for soil that include some organic pollutants. After application of compost at a rate of 10 t dry matter ha⁻¹, all criteria were found to be met with huge margins. The Netherlands decided against setting limits, as levels are considered too low to cause concern. Little information is available on the levels at which organic pollutants become hazardous. Opinions differ and research is lacking. It has also been noted that results of analyses vary widely even when performed on material from the same heap. CEN/TC 223 WG2 concluded that information was too unreliable to base limits on and therefore was unable to recommend any (Bywater, 1998).

Table A2- 11: Limit and guide values for organic compounds in compost compared with other orientation values

	COMPOSTS				SOIL		Excavated soil
	Austria ¹ MSWC only	Luxembourg ² BWC <i>fresh and matured compost</i>	Denmark ³ BWC <i>1 anal. y⁻¹</i>	Baden- Württemb. ⁴ BWC	Germany ⁵		
					SOM > 8%	SOM ≤ 8%	Austria ⁶
PCB mg kg ⁻¹ d.m.	1	0.1 <i>(4 anal. y⁻¹)</i>		0.2	0.1	0.05	0.1
PCCD/F ng ITEQ kg ⁻¹ d.m.		20 ng kg ⁻¹ d.m. <i>(4 anal. y⁻¹)</i>		17 +30% tolerance: 22			
Dioxins ng I-Teq kg ⁻¹ d.m.	50				5-40*		
PAH ₁₆ mg kg ⁻¹ d.m.	6	10 <i>(2 anal. y⁻¹)</i>	3		10	3	2
Benzo(a)pyrene mg kg ⁻¹ d.m.					1	0.3	0.2
AOX mg kg ⁻¹ d.m.	500						
Hydrocarbons mg kg ⁻¹ d.m.	3,000						20, 50, 100, 200 ⁷
LAS mg kg ⁻¹ d.m.			1,300				
NPE mg kg ⁻¹ d.m.			10				
DEHP mg kg ⁻¹ d.m.			50				

¹ Austrian Compost Ordinance, limit values for mixed municipal solid waste compost. Analyses every 500 t MSWC production; use of MSWC only as landfill reclamation layer or as bio-filter.

² guide value

³ limit value, Statutory Order Nr.49

⁴ guide values of the Composting Decree of Baden-Württemberg (GE),

⁵ precautionary values of the German Soil Protection Ordinance; differentiated for soils with > 8 % and ≤ 8 % organic matter content (SOM)

⁶ BMLFUW (2001)

⁷ differentiated limit values for the agricultural use of excavated soils with TOC ≤ 0,3%, 0,3% < TOC ≤ 0,5%, 0,5% < TOC ≤ 2% and TOC > 2% respectively. * working group on Dioxins Germany, 1992