

**PAS 100:2018**

**PUBLICLY AVAILABLE SPECIFICATION**

# **Specification for composted materials**

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## Foreword

This PAS is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on XXX 2018. This PAS was sponsored by Renewable Energy Assurance Ltd (REAL). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on [DD MMM YYY].

Acknowledgement is given to the following organizations that were involved in the development of this PAS as members of the steering group:

- LIST STEERING GROUP MEMBERS;

### Publication status

This PAS has been prepared and published by BSI, which retains its ownership and copyright. The BSI copyright notice displayed in this document indicates when the document was last issued. This edition supersedes PAS 100:2011, which is withdrawn.

PAS 100 is not to be regarded as a British Standard and will be withdrawn upon publication of its content in, or as, a British Standard.

This PAS is not intended to restrict new developments in design and materials. Accordingly, all feedback about it and proposals for future work will be considered. It will be reviewed as and when the technical need arises or after two years, whichever is sooner. BSI reserves the right to withdraw or amend this PAS on receipt of authoritative advice that it is appropriate to do so.

### Presentational conventions

The provisions of this PAS are presented in upright, roman type. Its requirements are expressed in sentences in which the principal auxiliary verb is 'shall'.

Commentary, explanation (guidance) and general informative material is presented in smaller italic type, and does not constitute normative elements (requirements). Much of this appears as notes in this PAS, each beginning with 'NOTE', and other such material appears in the annexes marked 'informative'.

### Conformity and certification

Marking PAS 100:2018 on or in association with compost represents a composter's declaration of conformity, i.e. a claim by or on behalf of the composter that the requirements of this PAS have been met. The accuracy of the claim is therefore solely the responsibility of the person or organization making the claim. Such a declaration is different from third party certification of conformity with this PAS. Composters should note the Compost QP's requirement for third party certification when demonstrating that compost derived from controlled biowaste is no longer subject to waste regulatory controls (see Introduction's 0.2, fourth paragraph).

### Contractual and legal considerations

This PAS does not purport to include all the necessary provisions of a contract. Composters and any other parties who use this PAS are responsible for its correct application.

Compliance with a PAS does not in itself confer immunity from legal obligations. Neither does certification of conformity by a third-party.

In addition to the requirements of this PAS, attention is drawn to the following statutory requirements, Codes of Good Agricultural Practice, Quality Protocols and other guidance:

**Comment [JG1]:** NOTE TO REVIEWERS: All references remain unchanged & will be updated at the next iteration

- [1] Environmental Protection, The Environmental Protection Act 1990 (as amended);
- [2] Town and Country Planning General Regulations 1992;
- [3] Planning Policy Statement 10: Planning for Sustainable Waste Management, July 2005;
- [4] Environmental Permitting (England and Wales) Regulations 2007, Annex 2 – Schedule 20 to the Environmental Permitting Regulation 68 (3);
- [5] Town and Country Planning (Scotland) Act 1997;
- [6] Planning etc. (Scotland) Act 2006 (asp 17);
- [7] The Planning (Northern Ireland) Order 1991;
- [8] The Environmental Permitting (England and Wales) Regulations 2007 <sup>1)</sup>;
- [9] The Waste Management Licensing Regulations 1994 (as amended);
- [10] The Waste Management Licensing Amendment (Scotland) Regulations 2006;
- [11] The Pollution Prevention and Control Act 1999;
- [12] The Waste Management Licensing (Northern Ireland) Regulations 2003;
- [13] The Pollution Prevention and Control Regulations (Northern Ireland) 2003;
- [14] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives;
- [15] Directive 2000/532/EC. European Waste Catalogue (known as the consolidated version) 2001;
- [16] The List of Wastes (England) Regulations 2007;
- [17] The List of Wastes (Wales) Regulations 2005;
- [18] The List of Wastes Regulations (Northern Ireland) 2005;
- [19] The Packaging (Essential Requirements) Regulations 2003 (as amended);
- [20] EU Regulation 1069/2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing regulation EC No. 1774/2002 (Animal By-Products Regulation) [enters into force 4<sup>th</sup> March 2011];
- [21] EU Regulation 1774/2002 laying down health rules concerning animal by-products not intended for human consumption (as amended) [22], and implementing these in;
  - [23] England, The Animal By-Products Regulations 2005 (as amended),
  - [24] Wales, The Animal By-Products Regulations 2006 (as amended),
  - [25] Scotland, The Animal By-Products Regulations 2003 (as amended), and
  - [26] Northern Ireland, The Animal By-Products Regulations 2003 (as amended);

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<sup>1)</sup> The Environmental Permitting (England and Wales) Regulations are a set of regulations that replace over 41 statutory instrument regulations, thus streamlining the waste management licensing and pollution control regimes into a single permitting and compliance system. The first phase regulations were published on 13 December 2007 and came into force on 6 April 2008, and the second phase regulations were published on 10 March 2010 and came into force on 6 April 2010. Their implementation respectively comprises the first and second phases of the Environment Agency, Defra and Welsh Assembly Government's Environmental Permitting Programme. Read more about the Environmental Permitting Programme at <http://www.defra.gov.uk/environment/policy/permits/about.htm> and <http://www.environment-agency.gov.uk/business/topics/permitting/default.aspx>

[27] EU Regulation 999/2001 laying down rules for the prevention, control and eradication of certain transmissible spongiform encephalopathies (as amended), and implementing these in;

[28] The TSE (England) Regulations 2002 (as amended);

[29] The TSE (Wales) Regulations 2002 (as amended);

[30] The Transmissible Spongiform Encephalopathies (Scotland) Regulations 2006 (as amended); and

[31] The Transmissible Spongiform Encephalopathies Regulations (Northern Ireland) 2002 (as amended);

[32] Regulation (EC) 852/2004 on the hygiene of foodstuffs;

[33] Regulation (EC) 853/2004 laying down specific hygiene rules for food of animal origin;

[34] Regulation (EC) 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption;

[35] The Fertilisers Regulations 1991;

[36] Consumer Protection, The General Product Safety Regulations 2005 (as amended);

[a] The quality protocol for the production and use of quality compost from source-segregated biodegradable waste (Compost QP);

[b] The quality protocol for the production and use of quality outputs from anaerobic digestion of source segregated biodegradable waste (AD QP);

[c] PAS 110, Specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials;

[d] Action Programme of Measures for Nitrate Vulnerable Zones;

[e] Protecting our Water, Soil and Air: A Code of Good Agricultural Practice for farmers, growers and land managers, Department for Environment, Food and Rural Affairs [only applicable in England];

[f] Code of Good Agricultural Practice for the Protection of Air, Ministry of Agriculture, Fisheries and Food, and the Welsh Office Agriculture Department (as amended) [now only applicable in Wales];

[g] Code of Good Agricultural Practice for the Protection of Soil, Ministry of Agriculture, Fisheries and Food, and the Welsh Office Agriculture Department [now only applicable in Wales];

[h] Code of Good Agricultural Practice for the Protection of Water, Ministry of Agriculture, Fisheries and Food, and the Welsh Office Agriculture Department [now only applicable in Wales];

[i] Scottish Executive, Prevention of Environmental Pollution from Agricultural Activity Code of Good Practice (PEPFAA code) [only applicable in Scotland];

[j] The Code of Good Agricultural Practice for the Prevention of Pollution of Water, Air and Soil, Countryside Management Branch of the Department of Agriculture and Rural Development, Northern Ireland.

*NOTE See the bibliography's sections on 'documents that are legislation' and 'documents that are not legislation'.*

In England and Wales, processes that compost controlled source segregated biowastes are required under legislation to have an authorization to operate or

register an exemption from authorization. An example of an authorization is an environmental permit (permits include waste management licences and exemptions issued prior to 6 April 2008 when the environmental permitting regulations [8] came into effect).

In Scotland and Northern Ireland, processes that compost biowastes must have a Waste Management Licence (WML) or register an exemption from licensing (see [10] for Scotland and [12] for Northern Ireland). For facilities treating Category 3 Animal By-Products, a Pollution, Prevention and Control Permit (PPC) may be required (see [11] for Scotland and [13] for Northern Ireland).

The use of composts made from controlled, source segregated biowastes is subject to environmental permitting in England and Wales [8], or waste management licensing regulations in Scotland [9] & [10] or Northern Ireland [12]. However, see **0.2** of the Introduction of this PAS for circumstances in which composts derived from controlled biowastes may be transported, stored and used without waste regulatory controls.

## **0 Introduction**

### **0.1 Use of composts**

Composts derived from source segregated biodegradable materials and wastes are used in agricultural, horticultural, land restoration, soft landscaping, sports recreation, and other markets in the UK. According to their grade (in terms of particle size range) and other properties, composts are supplied for use as soil improvers and mulches, as substrates for growing media, and as a significant ingredient in manufactured topsoils and turf dressings. Awareness of suitable uses for composts, the associated benefits and compost availability has improved considerably in recent years. Provisions for investment in composting are now routinely made with compost quality and potential markets in mind.

### **0.2 Waste recovery**

Efforts are being made to significantly reduce the millions of tonnes of biodegradable waste that are landfilled every year in the UK. The composting of biodegradable wastes prior to their landfill helps reduce later generation and emissions of methane. This benefit is maximized when composted material is permanently diverted from landfill and is of sufficient quality for supply to diverse markets.

The production, transport, storage and use of composts derived from controlled biowastes is subject to waste management controls and pollution prevention regulations, according to the country in which those activities take place.

Uncertainty over the point at which waste has been fully recovered and ceases to be waste within the meaning of Article 3(1) of the EU Waste Framework Directive (2008/98/EC) has inhibited the development and marketing of materials produced from waste which could be used beneficially without damaging human health and the environment. Interpretation of EU legislation is ultimately a matter for the European Court of Justice and there is now a substantial body of case law on the interpretation of the definition of waste in Article 3(1) of the Waste Framework Directive. Drawing on the principles established in this case law, it is possible to identify the point at which certain wastes cease to be waste and thus when the Waste Framework Directive's waste management controls no longer apply. It is now possible to specify a set of criteria for the product of a waste treatment process such that, if they are met, the product will no longer be regarded by the relevant regulatory authorities as waste.

In countries that have adopted the Compost QP [a] once biowaste-derived compost has been produced in compliance with the Compost QP (which includes conformance with PAS 100) and provided it is destined for use in a market designated in the Compost QP, it is not normally subject to waste regulatory controls. In a British country that has not adopted the Compost QP, biowaste-derived compost may no longer be subject to waste regulatory controls when PAS 100's requirements and any additional conditions set by the regulatory authority have been met. In countries that have adopted the Compost QP, third party certification of conformity to PAS 100 and the Compost QP is necessary for biowaste-derived compost to no longer be subject to waste regulatory controls. In Scotland, where the Compost QP has not been adopted, the regulatory authority requires third party certification of conformity to PAS 100, amongst the additional conditions the authority has set for biowaste-derived compost to no longer be subject to waste regulatory controls. Those considering transporting, storing and using biowaste-derived composts outside of waste regulatory controls in a British country should check the position of that country's regulatory authority responsible for protection of the environment.

Whilst compliance with this PAS (and the Compost QP in countries that have adopted it) helps composters demonstrate due diligence in the recovery of biodegradable waste materials, it does not exempt the compost from regulations, measures and

good practices that apply to both waste and non-waste materials, such as the Animal By-Products Regulations, groundwater protection controls, and the Action Programme of Measures for Nitrate Vulnerable Zones (see references in the Bibliography).

Those who use composts on agricultural land in England or Wales should ensure that the relevant parts of the Codes of Good Agricultural Practice for the Protection of Air, Water and Soils are followed (see [e] for England and [f], [g] and [h] for Wales). Similarly, those who use composts on agricultural land in Scotland should ensure that the relevant parts of the Prevention of Environmental Pollution from Agricultural Activity Code of Good Practice [i] are followed. Users of composts on agricultural land in Northern Ireland should ensure that the relevant parts of the Code of Good Agricultural Practice for the Prevention of Pollution of Water, Air and Soil [j] are followed.

This PAS is a non-statutory document so does not set regulatory limit values for the use of composts as “wastes”.

### **0.3 Control of hazards**

Compost can have properties that are hazardous when it is handled and used, consequently PAS 100 specifies its minimum quality, such that any risks associated with its handling and general use are limited to acceptable levels, when compost is handled and used as per good practice. In support of this, PAS 100 requires the composter to carry out Hazard Analysis and Critical Control Point (HACCP) planning, operate a Quality Management System (QMS), and supply clear information to the customer.

### **0.4 Changes from previous edition**

Review of PAS 100:2005 has examined all its aspects. WRAP has sponsored reviews of stability by laboratories, tomato plant and weed growth testing by laboratories, analysis of compost data on all PAS 100 specified parameters, and review of the method for testing tomato plant and weed growth in peat-amended compost samples.

PAS 100:2011 incorporates references to new legislation, guidelines and scientific reports and has been re-formatted to make it easier to use. It continues to require the composter's commitment to supply composts that are fit-for-purpose. However, it does not allow the composting of sewage sludge or its derivatives. This PAS does allow addition of digestates from anaerobic and aerobic digestion processes, subject to restrictions set out in PAS 100's scope and Clause 6. It also allows the composting process to utilize thermophilic aerobic digestion (TAD) instead of aerobic composting for the sanitization step (see the scope).

PAS 100:2011 specifies a different method to test for *E. coli* as an indicator of pathogens from faecal origin, a separately published method for testing physical contaminants and stones, and a clarified, separately published method for testing plant response and weeds content. Except for plant response and weed testing which is carried out on the principal compost grade, all other PAS 100 test parameters now apply to each compost grade for which PAS conformance is claimed. Upper limits on physical contaminants, including plastic, have been made more stringent as too has the upper limit on stones in a “mulch” grade.

Claims of conformance with this PAS are not allowed until compost is produced according to a validated QMS that meets the requirements of this PAS. After validation, although it is recommended that graded compost batches that are sampled and tested are kept on-site until their test results have been received and evaluated, such keeping on-site is no longer a requirement (see Clause 15). In the event of compost sample test result failure(s), this PAS requires the composter to investigate the cause, review whether the QMS needs to be amended and carry out further

graded compost batch testing (see Clause 16). Options for the management of any failed batch are specified (see Clause 15). After validation, if a graded compost batch is found to have failed any test after it has been dispatched for use as PAS 100 compost the composteer is required to notify the compost recipient and regulator (see Clause 15).

### **0.5 Supplementary requirements**

Those manufacturing or specifying products with technically demanding requirements can require compost with specific characteristics. Their requirements can cover a wider range of parameters or demonstrate higher quality than the minimum specified in this PAS. Examples include composts used as an ingredient in turf dressings and growing media, which are normally enhanced by compost maturation before it is dispatched for use (see Annex C for guidance).

Organic food and farming standards include restrictions on biowaste types from which composts may be made, if they are intended to be used within such organic systems. In the UK, the Department for Environment, Food and Rural Affairs maintains information about standards and certification schemes for organic land management and crop production systems including the use of composts.

*NOTE Further information is available at  
<http://www.defra.gov.uk/foodfarm/growing/organic/index.htm>*

**The composteer is responsible for identifying and meeting any supplementary criteria that compost specifiers and users require.**

## 1 Scope

This Publicly Available Specification (PAS) specifies requirements for the process of composting, the selection of input materials, the minimum quality of composted materials and the storage, labelling and traceability of compost products. It specifies requirements for a Quality Management System (QMS) for the production of composts to ensure they are consistently fit for their intended uses. It also requires Hazard Analysis and Critical Control Point (HACCP) assessment, which the composter takes into account when developing, implementing and reviewing the QMS.

*NOTE 1 HACCP assessment identifies relevant hazards and establishes critical control points and critical limits for ensuring that any risks associated with product use are controlled within acceptable limits.*

This PAS is for composts from a composting system into which only source segregated biowastes (see **3.63** and **3.9**) and/or biodegradable non-waste materials are fed.

Inputs to the composting process are allowed to include digestate (whole digestate, separated fibre or separated liquor) from an anaerobic digestion facility that processes only source-segregated biowastes and/or biodegradable materials as inputs, that is compliant with PAS 110 (see **6.1.6** and its notes).

Digestate (whole digestate, separated fibre or separated liquor) from a non-PAS 110 anaerobic or aerobic digestion process is only allowed to be added to a PAS 100 composting process if the digestate is made only from input materials allowed by PAS 100 (see **6.1.6** and its Notes).

*NOTE 2 See [c] in bibliography, section "References to documents that are not legislation". If in future PAS 110 includes Thermophilic aerobic digestion (TAD) (see 3.71) within its scope and the digestate from such a process complies with PAS 110, the digestate would be an eligible input material to a PAS 100 composting process.*

*NOTE 3 Attention is drawn to legislation that controls the use of digestates and the digestion process facilities that produce them (see 6.1). The production quality management and direct use of digestates in soil conditioning and other applications is specified in PAS 110:2010, where they are made using an anaerobic digestion process.*

This PAS allows a composting process to utilize thermophilic aerobic digestion (TAD, see **3.71**) for its sanitization step instead of aerobic composting (see Clause **8** Table 1) and the resulting compost can be claimed compliant with this PAS if all requirements are met. However, any whole digestate or separated liquor output arising from the TAD step that is not utilized in a subsequent aerobic composting step to form compost (see **3.17**) is not allowed to be claimed compliant with this PAS.

*NOTE 4 Requirements for the minimum quality of composts specify upper limits for human and animal pathogen indicator species, potentially toxic elements, microbial respiration rate (stability), physical contaminants, stones, and weed propagules. They also specify minimum plant response in a germination and growth test.*

This PAS does not specify tests for specific or indicator plant pathogens due to a lack of validated methods.

*NOTE 5 Annex B provides recommendations on composting temperature, moisture and duration that indicate a composting environment that can eradicate plant pathogens. It also includes reference to the Food and Environment Research Agency's Code of practice for the management of agricultural and horticultural waste [K] and the European and Mediterranean Plant Protection Organization's Guidelines for the management of plant health risks of biowaste of plant origin [I].*

PAS 100 is applicable to product-oriented composting processes and the composter is responsible for establishing and consistently fulfilling any additional quality needs the user has.

Vermi-composting is within the scope of this PAS where it follows a sanitization step of thermophilic aerobic composting or TAD (see 7.1).

PAS 100 does not apply to composting activities that do not require registration with the regulator, such as composting at home.

## 2 Normative references

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

AfOR MT PC&S, *Method to determine particle size distribution of composted material and its physical contaminant and stone contents*, Association for Organics Recycling, Wellingborough.

ASTM D6400, *Standard specifications for compostable plastics*

BS EN 13432, *Packaging – Requirements for packaging recoverable through composting and biodegradation – Test scheme and evaluation criteria for the final acceptance of packaging*

BS EN 13650, *Soil improvers and growing media – Extraction of aqua regia soluble elements*

BS EN 14995, *Plastics – Evaluation of compostability – Test scheme and specifications*

BS EN ISO 6579, *Microbiology of food and animal feeding stuffs – Horizontal method for the detection of Salmonella spp*

BS ISO 16772, *Soil quality – Determination of mercury in aqua regia soil extracts with cold-vapour atomic absorption spectrometry or cold-vapour atomic fluorescence spectrometry*

BS ISO 16649-2, *Microbiology of food and animal feeding stuffs – Horizontal method for the enumeration of  $\beta$ -glucuronidase-positive Escherichia coli – Part 2: Colony count technique at 44 °C using 5-bromo-4-chloro-3-indolyl- $\beta$ -D-glucuronide*

*NOTE* In addition to the incubation instructions in BS ISO 16649-2:2001, 9.2.3, compost samples tested for PAS 100 purposes are required to undergo pre-incubation for an initial period of 4 hours at 37 °C, as per the "WARNING" text in the method's 9.2.3 with regard to "presence of stressed cells".

The following normative documents contain provisions which constitute provisions of BS ISO 16649-2:

BS ISO 7218, *Microbiology of food and animal feeding stuffs – General rules for biological examinations*

BS ISO 6887-1, *Microbiology of food and animal feeding stuffs – Preparation of test samples, initial suspension and decimal dilutions for microbiological examination – Part 1: General rules for the preparation of the initial suspension and decimal dilutions*

DIN V 54900, *Testing of the compostability of plastics*

Program OK 2, *Home compostability of products*, AIB-Vinçotte International s.a. / n.v., Vilvoorde, Belgium <sup>2)</sup>.

OFW004-006, *Plant response and weeds test for composted material*, Waste & Resources Action Programme, Banbury <sup>3)</sup>.

ORG 0020, *Standardised method for the determination of compost stability by measurement of evolved carbon dioxide*, Waste & Resources Action Programme, Banbury <sup>4)</sup>.

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<sup>2)</sup> Last published by AIB-Vinçotte International s.a. / n.v. on 01/12/2007, Edition C, document reference OK2-e.

<sup>3)</sup> First published by the Waste & Resources Action Programme, Banbury, September 2010, version 1.0, ISBN 1-84405-425-X.

<sup>4)</sup> First published as Annex A in a report by Llewelyn, H. R., and Farrington, D., Development of standard laboratory based test to measure compost stability, Direct Laboratories, Wolverhampton. Report published by the Waste & Resources Action Programme, Banbury, January 2005, ISBN 1-84405-143-9.

### 3 Terms and definitions

For the purposes of this PAS the following terms and definitions apply.

#### 3.1 agriculture

includes horticulture, fruit growing, seed growing, livestock farming, the use of land as grazing land, meadowland, osier land<sup>5)</sup>, land used for growing arable crops (such as cereals, oil seed rape and some types of vegetables) and biomass grown for non-food purposes, market gardens and nursery grounds, and woodlands where the land used is ancillary to the farming of land for other agricultural purposes

*NOTE In this context, horticulture means only "soil-/field-grown horticulture", a separate term which is defined further on in this section.*

#### 3.2 anaerobic digestion (AD)

process of controlled decomposition of biodegradable materials under managed conditions where free oxygen is absent, at temperatures suitable for naturally occurring mesophilic or thermophilic anaerobic and facultative bacteria species, that convert the inputs to a methane rich biogas and whole digestate

*NOTE Digestates can confer benefits to soils to which they are applied and the plants those soils support.*

#### 3.3 actively managed composting period

period of composting during which sanitization and stabilization normally occur

*NOTE See 3.43 for definition of "maturation".*

#### 3.4 additional compost grade

grade of compost that is not the principal compost grade

*NOTE See 3.51 for definition of "principal compost grade".*

#### 3.5 animal by-product (ABP)

entire bodies or parts of animals or products of animal origin referred to in Articles 4, 5 and 6 of EU Regulation 1774/2002 that are not intended for human consumption, including ova, embryos and semen

*NOTE Articles 4, 5 and 6 of EU Regulation 1774/2002 [21], as amended [22], respectively state Category 1, Category 2 and Category 3 animal by-products. "Not intended for human consumption" also means material that at some point was intended for human consumption but which has become unfit for that purpose. Most arisings of catering waste (see 3.10 and 3.11) and "former foodstuffs" are Category 3 ABPs, which can be recovered using a composting process. EU Regulation 1069/2009 [20] will come into force on 4<sup>th</sup> March 2011, repealing EU Regulation 1774/2002; the new regulation's definitions of animal by-products and their categories will supersede those in the repealed regulation and the definition of animal by-product in this PAS.*

#### 3.6 authorization

In the context of a composting activity, one of the following:

- in England and Wales, an Environmental Permit issued under the Environmental Permitting (England and Wales) Regulations 2007 [8], or a registered exemption from an Environmental Permit;

*NOTE A Waste Management Licence issued under the Environmental Protection Act 1990 [1] as amended by the Waste Management Licensing Regulations 1994 [9] (as amended) is now an Environmental Permit.*

<sup>5)</sup> Osier land is not included in Northern Ireland's definition of agriculture.

- in Scotland, a Licence issued under the Environmental Protection Act 1990 [1] as amended by the Waste Management Licensing Amendment (Scotland) Regulations 2006 [10], or a registered exemption from a Licence, or a PPC permit issued under the Pollution Prevention and Control (Scotland) Regulations 2000 [11]; or
- in Northern Ireland, a Licence issued under the Waste Management Licensing (Northern Ireland) Regulations 2003 [12], or a registered exemption from a Licence, or a PPC Permit issued under the Pollution Prevention and Control Regulations (Northern Ireland) 2003 [13].

### 3.7 blended material

mixture of a composted material and one or more other material(s)

*NOTE Other materials can include mineral additives, e.g. sand, soil, peat, non-composted biodegradable residues, other substrates, e.g. coir and bark, nutrient sources, or other compost from a different production system.*

### 3.8 biodegradable

capable of undergoing biologically-mediated decomposition

### 3.9 biowaste

waste of animal or plant origin which, for recovery purposes, can be decomposed by micro-organisms, other larger soil-borne organisms or enzymes

*NOTE A narrower definition of biowaste in Article 3(4) of the EU Waste Framework Directive (2008/98/EC) [14], set for the purposes of that directive, is "biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants". Article 3(1) of this Directive defines "waste" as "any substance or object which the holder discards or intends or is required to discard". The following biodegradable materials are not "biowaste": faecal matter (if not destined for incineration, landfilling or use in a biogas or composting plant), straw and other natural non-hazardous agricultural or forestry material used in farming or the production of energy from such biomass through processes or methods which do not harm the environment or endanger human health (see Article 2(1)(f) of Directive 2008/98/EC). Soil materials with no significant biowaste content that are within the scope of Article 2(1)(c) or 2(4) of Directive 2008/98/EC are not "biowaste". For the purposes of this PAS, 3.9 "biowaste" applies, as guided by this note.*

### 3.10 catering waste (including meat)

all waste food, including used cooking oil, originating in restaurants, catering facilities and kitchens, including central kitchens and household kitchens

*NOTE Due to the risk of pathogen transfer from meat to non-meat food fractions at catering waste sources, EU Regulation 1774/2002 [21] includes any non-meat food fractions arising at the premises in the definition of "catering waste", by using the word "all". Most catering wastes are Category 3 ABPs. However, catering waste from means of transport operating internationally is classified as a Category 1 ABP, which is not permitted to be composted.*

### 3.11 catering waste (excluding meat)

separately collected catering waste types where appropriately authorized measures have been taken to exclude meat at source

*NOTE For further information on this type of catering waste see [UK standards for catering waste section of Defra's 'Using animal by-products at compost and biogas sites', downloadable from https://www.gov.uk/guidance/using-animal-by-products-at-compost-and-biogas-sites#when-you-can-meet-uk-standards](https://www.gov.uk/guidance/using-animal-by-products-at-compost-and-biogas-sites#when-you-can-meet-uk-standards) by clicking on the text-embedded link 'Composting briefing note'. If catering waste excluding meat is subsequently mixed with any catering waste that includes meat, the mixture is classified as "meat-included catering waste" (see 3.10) and treated accordingly.*

### 3.12 certification

third-party attestation related to products, processes, systems or persons

*NOTE 1 In the context of PAS 100, assessment by a certification body covers all the requirements of PAS 100.*

*NOTE 2 In the context of the Compost QP [a] assessment by an approved certification body covers all the requirements of that protocol, including all those in the composter's chosen, approved standard / specification (e.g. PAS 100).*

### **3.13 certification body**

organization responsible for assessing and certifying the conformity of production systems, products or other materials to one or more relevant standards

*NOTE In this context, conformity of compost and its production process to the requirements of PAS 100.*

### **3.14 competent authority**

central authority of a Member State competent to ensure compliance with the requirements of the EU Animal By-products Regulation 1774/2002 [21] (as amended) or any authority to which that central authority has delegated that competence

*NOTE In England, Wales and Scotland, the competent authority is 'Animal Health' the executive agency of the Department for Environment, Food and Rural Affairs (Defra) and the Scottish Government. Animal Health was formerly named the State Veterinary Service. In Northern Ireland the competent authority is the Department of Agriculture and Rural Development and within that, the Veterinary Service.*

### **3.15 competent authority approval**

approval from the competent authority for composting catering waste or animal by-products, according to a defined process at a specific location

*NOTE The law requires each process treating catering waste or animal by-products to have approval from the competent authority. The assessment process starts with an "approval in principle" and progresses through a number of phases to approval.*

### **3.16 competent authority validation**

validation required by the competent authority in compliance with animal by-products regulations

### **3.17 compost**

solid particulate material that is the result of composting, that has been sanitized and stabilized and that confers beneficial effects when added to soil, used as a component of a growing medium, or is used in another way in conjunction with plants

*NOTE For the purposes of this PAS, the solid particles output resulting from a composting process that utilizes TAD instead of aerobic composting for its sanitization step is regarded as compost.*

### **3.18 composter**

business enterprise, organization, community initiative or person(s) responsible for the production of compost

### **3.19 composting**

process of controlled biological decomposition of biodegradable materials under managed conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat **that convert the inputs to compost and / or mulch**

***NOTE Composts and mulches can confer benefits to the soils and media to which they are applied and the plants those soils support.***

*This definition of composting is appropriate to the aims and scope of this PAS. It is recognized that there are other forms of composting that are unlikely to **be managed sufficiently to** achieve and sustain thermophilic temperatures (see 3.72). Home composting is such an example. Vermicomposting is maintained within a very restricted, low temperature range suitable for the existence of appropriate,*

selected species of worms. For the purposes of this PAS a composting process that utilizes TAD (see 3.71) instead of aerobic composting for its sanitization step may be regarded as a composting process.

### **3.20 composting / composted / compost batch**

identifiable quantity of material that progresses through a composting system and when fully processed, has similar characteristics throughout

*NOTE Composting systems that operate on a continuous- or plug-flow basis will carry out monitoring and assessment on a series of "portions of production" rather than batches. Where "composting batch" is used elsewhere in this PAS, composters operating such systems may interpret this as "portion of production". A mass balance approach that takes account of composting process throughput rates (input tonnage and weight reduction over a known period of time) can be used to allocate and trace each portion of production. Clause 8.2 requires that the composter's appropriate QMS document(s) identify typical, maximum and minimum composting batch sizes.*

### **3.21 composting / composted / compost batch code**

unique reference for a composting / composted / compost batch

*NOTE In this definition "batch" can also mean portion of production. For simplicity, the composted / compost batch code can remain the same as the composting batch code, provided that the material comprises solely the "carried forward" composting batch. Composters operating continuous-flow or plug-flow systems should interpret "compost batch code" as "portion of production code".*

### **3.22 compost grade**

means of differentiating composts from the same composting process in terms of their particle size ranges

*NOTE Normally derived by passing composted material through screening machinery; each screening step normally resulting in one stream of particles that have fallen through the screen's apertures / moving plates and a second stream of particles that have not fallen through. The number of grades produced by a single screening step depends on machine design and chosen settings when in use.*

### **3.23 control (noun)<sup>6)</sup>**

state wherein correct procedures are being followed and criteria are being met

### **3.24 control (verb)**

to take all necessary actions to ensure and maintain compliance with criteria established in the HACCP plan

### **3.25 corrective action**

any action to be taken when the results of monitoring at the critical control point (CCP) indicate a loss of control

### **3.26 critical control point (CCP)**

step at which control can be applied and is essential to prevent or eliminate a hazard or reduce it to an acceptable level of risk

### **3.27 critical limit (CL)**

criterion which separates acceptability from unacceptability

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<sup>6)</sup> Definitions 3.23 to 3.28 and definition 3.55 are from the Codex Alimentarius, Food Hygiene Basic Texts (see reference [p] in the bibliography's section on 'References that are not legislation' and Annex A for more information). Minor changes have been made to some to make them more appropriate within the context of compost production.

*NOTE The critical limit for any parameter will depend on how the product is manufactured and intended to be used. In PAS 100 context, assess critical limits appropriate to the compost production process, taking account of how the compost is intended to be used.*

### **3.28 deviation**

failure to meet a critical limit

### **3.29 digested materials**

whole digestate resulting from an anaerobic or aerobic digestion process, and any subsequently separated fibre or liquor

*NOTE 1 Given the scope of this PAS and PAS 110, "digested material" includes any separated fibre that undergoes a subsequent aerobic stabilization step, without addition of further biodegradable materials.*

*NOTE 2 See definitions of terms, whole digestate (3.84), separated fibre (3.60) and separated liquor (3.61).*

### **3.30 duty of care**

any individual who is the holder of controlled waste is obliged under law to ensure that the waste is managed properly, is recovered or disposed of safely, does not cause harm to human, animal or plant health or pollution of the environment, and is transferred only to someone who is authorized to receive it

*NOTE Duty of care applies to any person who produces, imports, carries, keeps, treats or disposes of controlled waste or, as a broker, has control of such waste, i.e. it applies to anyone who is the holder of controlled waste. It is a requirement in section 34 of the Environmental Protection Act 1990 (as amended) [1] and associated regulations. Article 13 of the EU Waste Framework Directive (2008/98/EC) [14] obliges those who manage waste to ensure their activities are carried out 'without endangering human health, without harming the environment and, in particular: (a) without risk to water, air, soil, plants or animals; (b) without causing a nuisance through noise or odours; and (c) without adversely affecting the countryside or places of special interest'.*

### **3.31 exemption**

exemption from the need to hold an authorization, allowed by the regulator in certain circumstances

*NOTE 1 See 3.6 for definition of authorization; see 3.82 for definition of waste management licence.*

*NOTE 2 In Scotland, a composting activity is exempt from waste management licensing if it meets the requirements of regulation 18 and Schedule 3 of the Waste Management Licensing Regulations 1994 (as amended) [9]. The exempt activity is registered with the regulator. Separate exemptions exist in the nations/provinces/administrations of the UK for spreading composted, controlled biowastes on land.*

### **3.32 fit-for-purpose**

having all of the properties and characteristics necessary for its intended use(s)

*NOTE In the context of PAS 100, "fit-for-purpose" compost passes all PAS 100 obligatory tests and any additional parameter tests and limits the composteer has committed to fulfilling in his/her quality policy or in a written agreement with a compost customer.*

### **3.33 flow diagram**

systematic representation of the sequence of steps or operations used in the production or manufacture of each compost grade

### **3.34 growing medium**

material, other than soils in situ, in which plants are grown

[PD CR 13456:1999]

### **3.35 harm**

physical injury or damage to the health of people or damage to property or the environment

[ISO/IEC Guide 51]

*NOTE Within the context of this PAS, harm also includes injury or damage to the health of plants, the health and welfare of animals, and pollution of the environment. Harm can be caused by one or more unwanted biological, chemical or physical agents in compost or by its misuse.*

### **3.36 hazard**

potential source of harm

### **3.37 hazard analysis**

process of collecting and evaluating information on hazards and conditions leading to their presence, to decide which are significant for the production of compost that is fit-for-purpose

*NOTE This is carried out when drawing up the HACCP plan.*

### **3.38 HACCP plan**

document prepared in accordance with the principles of HACCP to ensure control of hazards that are significant for the production, storage, supply and use of compost without harm

### **3.39 Hazard Analysis and Critical Control Point (HACCP) study**

system which identifies, assesses, and controls hazards which are significant for compost safety and quality

*NOTE In the context of this PAS, the focus of safety is those hazards which are significant for the production and use of digested materials without harm to the environment (including human, animal and plant health).*

### **3.40 horticulture (soil-/field-grown)**

raising of plants in soil in-situ, in a field or under protective cover

*NOTE Includes the commercial raising of plants referred to in the definition of "agriculture" and some types of vegetables, fruit, flowers and bulbs, hardy and other nursery stock, herbs as well as some protected crops grown in soil in-situ.*

### **3.41 input material**

source segregated biowaste or source segregated biodegradable material intended for feeding or that is fed into a composting process

*NOTE 1 See further criteria in Clause 6.*

*NOTE 2 See Annex B of the Compost QP [a] for the list of acceptable input materials (selected from the European Waste Catalogue [15].*

### **3.42 land manager**

natural or legal person, or a group of natural or legal persons, whatever legal status is granted to the group and its members by national law, whose holding is situated within the EU and who exercises a land management activity

### **3.43 maturation**

period of lower rate biodegradation than in preceding steps of composting (sanitization and stabilization)

*NOTE For the purposes of this PAS, this step occurs after the actively managed period, prior to or after any compost screening. "Maturation" is a monitored and evaluated phase of managed composting, even if it does not undergo 'action' treatment; it is not to be regarded as "compost storage". The regulator requires that composting batches undergoing maturation are kept within the area covered by the composting permit/waste management licence/exemption.*

### **3.44 mature, maturity**

state of composted material which exhibits a very low rate of biodegradation and which is not harmful to humans or animals and does not exert phytotoxic effects in any application

*NOTE See also definition of term 3.66, "stable".*

### **3.45 mesophilic micro-organisms**

micro-organism species for which optimum growth temperatures are within the range 30 °C to 45 °C

### **3.46 methods of test**

procedures for testing samples of materials

*NOTE Where available for any one or more parameters, this PAS specifies recognized national, European Community or international standards published by the British Standards Institution (BSI), the European Committee for Standardization (CEN) and the International Organization for Standardization (ISO).*

### **3.47 monitor**

act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control

### **3.48 mulch**

material spread and allowed to remain on the soil surface to conserve soil moisture, suppress weeds and shield soil particles from the erosive forces of raindrops and runoff

[derived from PD CR 13456:1999]

*NOTE Nutrients in the mulch will slowly become available to plants as its particles gradually biodegrade. The total amounts and rates at which different nutrients are released is influenced by the nature of the particles comprising the mulch (e.g. their carbon to nitrogen ratio and particle size distribution).*

### **3.49 phytotoxin**

substance that is toxic to plants

*NOTE Toxicity effects might include delayed seed germination or inhibited plant development and rate of growth.*

### **3.50 potentially toxic element (PTE)**

chemical element that has potential to have toxic effects on humans, flora or fauna, or can do so in combination with other chemical elements

*NOTE Some PTEs are also known as "heavy-" or "transition metals", such as lead, cadmium, chromium, mercury, copper, zinc and nickel. These are the seven PTEs specified in Table 3 of this PAS.*

### **3.51 principal compost grade**

grade of compost for which PAS 100 conformance is claimed, or intended to be claimed, normally the one that is composted for the shortest total time and includes sufficient particles less than 2 mm to support plant germination and growth

*NOTE For example, the principal grade could not be a 10 mm to 40 mm mulch grade because it would not contain the fine particles that are necessary for plant response and weed seed tests. Although not necessarily made from every batch of compost production, the principal grade should be made on a frequent basis and the quantity made over a year should be at least as much as any additional compost grade (see 3.4) for which PAS 100 conformance is claimed.*

### **3.52 quality control**

part of quality management focused on fulfilling quality requirements

*NOTE Implemented through a series of systems and activities, which are integrated in daily work, and enable frequent, or continuous, verification of product quality. Examples are checks on process conditions throughout every processing step, digested material sample test results and the effects of any corrective actions taken.*

### **3.53 quality management system (QMS)**

management system to direct and control an organization with regard to quality

*NOTE In the context of composting, it is a system for planning, achieving and demonstrating effective control of all operations and associated quality management activities necessary to achieve compost that is fit-for-purpose. Where specific controls are applied, they are monitored and recorded, and their efficacy evaluated both during and after process validation. Corrective actions are defined.*

### **3.54 quality protocol (QP)**

set of criteria for the production, placement on the market, storage and use of products derived from defined types and sources of waste, such that any risks to the environment and to human and animal health are acceptably low when any such product may, under certain circumstances, be used without waste regulatory controls, in those countries in which the QP applies

*NOTE A QP also sets out how compliance with its criteria can be demonstrated. Under a QP, the product should be used in accordance with good practice, and appropriate guidance is referred to where available and suitable for use of the product in end markets allowed by the QP.*

### **3.55 risk**

combination of the probability of occurrence of harm and the severity of that harm [ISO/IEC Guide 51]

*NOTE Can mean the potential realization of unwanted, adverse consequences to human life, health, property or the environment associated with a hazard. Consideration of a hazard does not necessarily mean that it is applicable. For each of any hazard deemed applicable, identifying a way to control the associated risk within an acceptable level is part of HACCP planning (see 3.39).*

### **3.56 sanitary, sanitized**

degree of processing and biodegradation at which any human and animal pathogens present have been reduced to acceptable levels (see Table 3, items 1 & 2)

*NOTE to 3.56 and 3.57 See Annex B for recommendations for eradication or reduction of plant pathogens. Composters should operate the sanitization step so that it also reduces any plant pathogens to an acceptably low level, or preferably eradicates them.*

### **3.57 sanitization**

biological processes that together with conditions in the composting batch eradicate human and animal pathogens or reduce them to acceptably low, sanitary levels

*NOTE See Table 3, items 1 and 2.*

### **3.58 screening (of composted material)**

process stage that separates compost particles according to their size, in order to achieve one or more separate grades of compost in terms of particle size range

### **3.59 senior management**

individual, or team of individuals, at the highest level of organizational management who have the day-to-day responsibilities of managing an organization, and who hold(s) specific executive powers conferred onto him/her/them with and by authority of the organization's board of directors and/or its shareholders

### **3.60 separated fibre**

fibrous fraction of material derived by separating the coarse fibres from whole digestate

*NOTE It is normally separated using a separator or centrifuge to reduce its moisture content to such an extent that it can be stored, sampled, tested and used as a stackable, "solid" material. As a guideline, if  $\geq 23$  % mass/mass of the separated fibre is dry matter it is likely to be stackable, "solid" material.*

### **3.61 separated liquor**

liquid fraction of material remaining after separating coarse fibrous particles from whole digestate

*NOTE It is normally separated using a separator or centrifuge to remove coarse fibres.*

### **3.62 sewage sludge**

solid, semi-solid or liquid by-product arising from the treatment of sewage or from septic tanks or similar installations

*NOTE The term "biosolids" is an alternative also used especially as fertilizer in agriculture.*

### **3.63 source segregated**

materials or biowastes of the types and sources sought, that are stored, collected and not subsequently combined with any other non-biodegradable wastes, or any potentially polluting or toxic materials or products, during treatment or storage (before or after treatment)

*NOTE Source segregated materials can include collection of a mixture of biowaste/biodegradable material types, from more than one source. It is acknowledged that for some types/sources of biowaste low levels of physical contamination could occur, which can trigger rejection of an input material load or physical contaminant removal prior to shredding and forming the biowaste / biodegradable material into composting batches. See 6.1.3 regarding packaged biowastes/biodegradable materials.*

### **3.64 sharps**

man-made contaminants that are greater than 2 mm in any dimension that can cause physical injury to a person or animal who comes into contact with these materials, including a person who handles composted materials without protective gloves

### **3.65 soil improver/soil conditioner**

material added to soil in situ primarily to maintain or improve its physical properties, and which can improve its chemical and/or biological properties or activity

[PD CR 13456:1999]

### **3.66 stable, stabilized**

degree of processing and biodegradation at which the rate of biological activity has slowed to an acceptably low and consistent level and will not significantly increase under favourable, altered conditions

*NOTE This may be indicated by a downward trend in temperatures within the composting mass and, amongst other parameters, slower oxygen uptake rate or carbon dioxide evolution. Stable compost is unattractive to vermin, without noxious odour and does not support the re-growth of pathogens. It can still contain substances from natural or anthropogenic sources that are insufficiently biodegraded such that they exert phytotoxic effects in some applications.*

### **3.67 stabilization**

biological processes that together with conditions in the composting mass give rise to compost that is nominally stable

*NOTE After stabilization, biodegradation will continue to occur, albeit at a slower rate.*

### **3.68 standard operating procedures (SOPs)**

procedures for producing compost

*NOTE The SOPs cover details of each critical control point, the critical limits of each relevant parameter, other aspects of the HACCP plan, and operational aspects of the QMS. Composting carried out under an environmental permit/waste management licence follows procedures stated in the*

*operational/management plan approved by the regulator. PAS-related procedures can be incorporated in it but are normally stated in separate SOPs document, which complements and cross-references the environmental permit/waste management licence and regulator-approved operational/management plan.*

### **3.69 step**

point, procedure, operation or stage in compost production, from receipt of input materials through to storage and dispatch of compost

### **3.70 stones**

extraneous, hard mineral matter greater than 4 mm in any dimension

*NOTE Does not include glass, plastic or metal, but does include pebbles and pieces of aggregate, concrete and pottery.*

### **3.71 thermophilic aerobic digestion (TAD)**

process of controlled decomposition of biodegradable materials, where naturally occurring micro-organism species suited to thermophilic, aerobic conditions convert the biodegradable materials into water vapour, carbon dioxide rich gasses and whole digestate

### **3.72 thermophilic micro-organisms**

micro-organism species for which optimum growth temperatures are within the range 45 °C to 80 °C

### **3.73 topsoil**

material with a mineral base which will perform the functions of natural topsoil and in which plants will grow healthily

[derived from BS 3882:2007]

### **3.74 toxin**

poisonous substance produced by some higher plants, animals and pathogenic bacteria that is capable of causing intoxication on contact with or absorption by body / plant tissues, by interacting with biological macromolecules such as enzymes or cellular receptors

### **3.75 toxicant (plural; toxics)**

man-made (synthetic) substance that presents a risk of death, disease, injury, or birth defects in living organisms through absorption, ingestion, inhalation, or by altering the organism's environment

### **3.76 traceability**

ability to trace via records the history of a compost batch, including identification of all the inputs used and all the production steps it has undergone

### **3.77 user(s)**

individuals or organizations that obtain compost from a composter or third party with the intention of using it

### **3.78 validation, validate**

obtaining and evaluating evidence that the elements of the HACCP plan are effective

*NOTE In the context of PAS 100, this includes obtaining and evaluating evidence that the QMS is effective for producing compost of the quality to which the composter has committed in the Quality Policy. See 4.5 for validation requirements in general, and Clauses 12, 13, 14, and 15 for more specific requirements.*

### **3.79 verification, verify**

application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with the HACCP plan

### **3.80 vermi-compost**

form of compost derived from the casts of selected species of worms used in vermi-composting

### **3.81 vermi-composting**

processing and biodegradation of wastes principally by appropriate worm species, in addition to micro-organisms

### **3.82 waste management licence (WML)**

licence issued by the regulator that allows a person(s) or organization to undertake an activity involving the deposit, keeping, treating or disposal of a controlled waste

*NOTE 1 In England and Wales, issued under the Environmental Protection Act 1990 (as amended) [1] and the Waste Management Licensing Regulations (as amended) [9]. In Scotland, issued under [1] as amended by the Waste Management Licensing Amendment (Scotland) Regulations [10]. In Northern Ireland, issued under the Waste Management Licensing (Northern Ireland) Regulations 2003 [12].*

*NOTE 2 Regulators are the Environment Agency in England and Wales, the Scottish Environment Protection Agency in Scotland, and the Northern Ireland Environment Agency. Controlled wastes arising in the nations of the UK are defined in section 75 of Part II of the Environmental Protection Act 1990 as amended [1].*

*NOTE 3 See 3.6 for definition of authorization (which includes Environmental Permits) and 3.31 for definition of exemption.*

### **3.83 waste regulatory controls**

controls under legislation that govern the transfer, transport, storage, handling, treatment, recovery and disposal of waste

### **3.84 whole digestate**

material resulting from a digestion process and that has not undergone a post-digestion separation step to derive separated liquor and separated fibre

## **4 Quality management system (QMS)**

### **4.1 General**

**4.1.1** A QMS specific to a defined composting process, its resulting composts, and any products that contain those composts shall be established and maintained.

**4.1.2** The QMS shall control all operations and associated quality management activities necessary to achieve compost that is fit-for-purpose (see **3.32**). Where specific controls are applied they shall be monitored, recorded and evaluated, both before and after process validation. Corrective actions shall be defined.

*NOTE The HACCP plan (see 3.39 and Clause 5) influences the quality policy (see 4.2) and SOPs (see 3.68 and 4.4) and should be regarded as part of the QMS.*

**4.1.3** Senior management shall:

- a) ensure sufficient resources (people, infrastructure, equipment, work environment) for the establishment, implementation, maintenance and improvement of the QMS;
- b) define QMS responsibilities and authorities and communicate them within the composter's organization;

- c) establish a quality policy for compost produced under the QMS (see 4.2);
- d) ensure that QMS communication processes are established within the composter's organization and that communication takes place regarding the QMS's efficacy; and
- e) conduct management reviews (see 4.10).

**4.1.4** Senior management shall appoint a member of the organization's management who, irrespective of other responsibilities, has the responsibility and authority to:

- a) ensure that QMS processes are established, implemented and maintained;
- b) report to senior management on QMS performance and any need for its improvement; and
- c) ensure that awareness of compost customers' requirements is promoted throughout the organization.

## **4.2 Compost quality**

The composter shall check and agree with the customer (e.g. specifier, buyer in the supply chain or if supplied directly, the end user) any quality requirements that are more stringent or wider ranging than the minimum baseline specified in this PAS. The composter shall ensure that the compost supplied meets the customer's requirements. There shall be a written agreement with customers of any quality requirements other than the minimum baseline specified in this PAS.

## **4.3 Quality policy**

The composter's quality policy shall include:

- a) identification of the location of the composting process, the process steps and compost grades it produces;
- b) identification of the principal compost grade (see 3.51) and any additional compost grade (see 3.4) for which PAS 100 conformance is claimed, or intended to be claimed;
- c) the composter's commitment to achieve the minimum quality and plant response requirements specified in Clause 14, as applicable to the grade;
- d) the composter's commitment to fulfilling customers' requirements regarding the compost grade(s) fitness for purpose; and
- e) identification of any product that contains any compost grade for which PAS 100 conformance is claimed or intended to be claimed.

## **4.4 Safety and Quality Control System**

### **4.4.1 Safety and Quality Control System shall consist of:**

- a) a HACCP study (see 4.4.1 and 4.5.1);
- b) the team members and their training and experience (see 4.3);
- c) the essential characteristics of the product, that is, description of the product and its intended use [(see 4.1.2, 4.2 and Clause 17 a), b), f) and i)];
- d) the steps in the production operation (see 4.4.1);
- e) keeping the HACCP plan up-to-date (see 4.6.1, 4.9 and 4.10).

**NOTE** For general guidance refer to the Codex Alimentarius Commission's relevant publications [reference] and to organizations that own certification schemes aligned to the requirements in this PAS.

The HACCP study shall be carried out in accordance with the Codex Alimentarius Commission's 'Principals of the HACCP system', namely:

- Principle 1 - conduct a hazard analysis (see 5.1.1);
- Principle 2 - determine the CCPs (see 5.1.2);
- Principle 3 - establish CLs (see 5.1.2);
- Principle 4 - establish a system to monitor control of the CCP (see 5.1.3 and Clause 8);
- Principle 5 - establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control [i.e. outside its CL(s)] (see 4.4.2 and 5.1.4);
- Principle 6 - establish procedures for verification to confirm that HACCP is working effectively (see 4.5 and 5.1.4); and
- Principle 7 - establish documentation concerning all procedures and records appropriate to these principles and their application (see 4.4, 4.7 and 5.1.4).

A systematic assessment of human, animal and plant health hazards associated with intended uses of the compost grade(s) for which PAS 100 conformance is, or intended to be, claimed shall be carried out. The hazards assessed shall include both safety and quality hazards relevant to the intended use.

*NOTE* HACCP planning is a basis for process design and operation that identifies which hazards and associated risks should be reduced to acceptable levels; in this context, meaning that composts are safe to use and fit-for-purpose. "Acceptable level" means achieving at least the minimum compost quality and plant response required in this PAS (see Tables 3 and 4) and any additional criteria that the composter has committed to meeting in his/her quality policy, according to customer needs.

The composter shall undergo assessment to assign CCPs in the composting process for hazards identified during hazards analysis (see 1.2.1). The CLs of the control measure(s) at the CCPs shall be established.

*NOTE* Where PAS 100 monitoring parameters are covered by regulatory requirements, the CLs are at least as stringent as the regulatory requirements and monitored as required by the regulator/competent authority.

Each composting batch shall undergo the CCP for each hazard identified by the composter. Under each CCP, the composting batch shall be monitored and managed such that the process step operates within its defined CLs.

These requirements shall apply both during and after process validation. Procedures shall be established for verification that the HACCP plan and its implemented CCPs and CLs are under control and that the HACCP system is working effectively. The HACCP plan and related procedures shall be documented.

## 4.5 Communication, awareness, training and competence

**4.5.1** The quality policy and relevant parts of the QMS shall be communicated to all personnel whose activities affect compost quality. They shall be made aware of the relevance and importance of their activities and how they contribute to achievement of the quality policy for compost.

**4.5.2** Senior management or the manager with QMS responsibilities shall determine the necessary competence for personnel performing work affecting compost quality.

**4.5.3** Each person whose activities affect compost quality shall be trained, instructed and supervised commensurate with his/her duties. **Operators shall demonstrate ongoing competence.** The training record for each such person shall include the:

- a) training topic;
- b) training date or period;
- c) name and role of the person who received the training on that topic;
- d) name of the person who delivered the training and organization he/she is representing/employed by (which can be the composter); and
- e) any certificate or qualification achieved.

*NOTE* These requirements also apply to the manager with overall responsibility for the QMS (see 4.1.5). Relevant training within the context of this PAS includes specific activities relating to controlling, monitoring and recording compost production as well as checks on whether production records and compost laboratory test results demonstrate adequate process control and compost quality. As appropriate to a person's responsibilities, training could include knowledge of the principles of aerobic biodegradation, composting techniques, QMS, HACCP assessment, other relevant standards, specifications and protocols, and markets for composts.

## 4.6 Standard operating procedures

**4.6.1** The composter shall write and implement standard operating procedures (SOPs) that cover all production steps from arrival of input materials through to storage and dispatch of composts and any products that contain them.

*NOTE* Such procedures take account of the HACCP plan and other requirements of this PAS.

**4.6.2** A QMS document shall include description of corrective action(s) **procedures** normally taken in the event of deviation from a CL at its CCP, quality failure of a sampled compost batch, or any other occurrence that causes, or could cause quality failure **(see clauses 15 and 16).**

*NOTE* Corrective action is a fundamental feature of HACCP planning. It can be accomplished rapidly and with a minimum of formal planning or it could be a more complex, long-term activity. The magnitude of the problem, or the degree of risk that ensues from the non-conformity, should be used to judge the speed and nature of the corrective action. The procedure should be appropriate to the nature of the operation, formalized and reviewed to ensure its continued adequacy.

## 4.7 Validation

**4.7.1** The composter shall validate that the QMS is effective for the production of compost that conforms to the requirements of this PAS, i.e. is fit-for-purpose and produced according to SOPs, based on the HACCP plan, that achieve all of the intended levels of control. Until validation is achieved, no batch or part batch of the compost grade(s) under assessment shall be dispatched with claim of PAS conformance.

**4.7.2** The composter shall:

- a) operate all of the CCPs within their CLs;
- b) from the results of monitoring the CCPs, verify that the process is performing as planned;

- c) if there is deviation beyond any CL, carry out corrective action;
- d) sample each compost grade for which PAS 100 conformance is intended to be claimed and send samples to a laboratory for testing (see Clauses **12** and **13**);
- e) check that test results of those compost grades comply with the minimum quality and plant response requirements set in Clause **14** and any additional specifications to which the composter has committed to meeting in his/her quality policy (see **4.2**);
- f) amend the HACCP plan if the process is under control (CCPs operating within their CLs) but is not producing sufficient quality compost; and
- g) repeat a) to e) inclusive if the HACCP plan is amended.

*NOTE It is important to time validation such that it covers any relevant hazards to humans, animals and plants that are intermittent or seasonal in input materials. For example, some plant pathogens may only be present at certain times of the year. The HACCP plan and SOPs might need to be reviewed and improvements implemented to achieve validation.*

**4.7.3** Sampling and testing of batches of each compost grade for which PAS 100 conformance is intended to be claimed shall continue until the results demonstrate three passes in a row for each applicable parameter specified in Clause **14** and in any additional specification to which the composter has committed to meeting in his/her quality policy (see **4.2**). For validation purposes, each sampled batch shall only be sampled once and in accordance with Clause **12**.

*NOTE See Clause 15 regarding non-conforming material.*

#### **4.8 After validation**

**4.8.1** The composter shall regularly check that the SOPs, based on the HACCP plan, continue to achieve all of the intended levels of control and that the compost is fit-for-purpose, i.e. the QMS remains effective.

**4.8.2** The composter shall:

- a) operate all of the CCPs within their CLs;
- b) from the results of monitoring the CCPs, verify that the process is performing as planned;
- c) if there is deviation beyond any CL, carry out corrective action;
- d) send samples of each compost grade for which PAS 100 conformance is claimed to a laboratory for testing (as instructed in Clauses **12** and **13**, the latter also specifying the minimum frequency after validation); and
- e) check that test results of those compost grades comply with the minimum quality and plant response requirements applicable as per Clause **14** and any additional specifications to which the composter has committed to meeting in his/her quality policy (see **4.2**).

*NOTE See Clause 15 regarding non-conforming material and also 4.10.5 which refers to significant, non-temporary change that triggers revalidation.*

#### **4.9 Documents and their control**

**4.9.1** Documents appropriate to the scope of the QMS shall be established. **An index of the documents comprising the QMS shall be maintained.**

*NOTE This PAS does not prescribe the format for a QMS. The composter's quality manual has to clearly set out the overall structure of the system, state the composter's objectives in relation to compost quality and cover all requirements of this PAS. Flow diagrams, charts or drawings can be used. Existing documents and records may be used as part of the QMS, where the QMS makes accurate and specific references to them.*

**4.9.2** Each document that is part of the QMS shall include:

- a) a title;
- b) a version number;
- c) a date of issue; and
- d) the name of the person who issued it.

*NOTE* Weighbridge system and waste transfer note documents are exempt from the requirements in this clause, if each record includes a unique record number.

**4.9.3** QMS documents shall be maintained in an orderly manner. Each QMS document shall be in place at its appropriate point(s) of use. Any document that becomes obsolete shall be promptly removed from its point(s) of use and, where appropriate, replaced with a revised and approved version. **Previous versions shall be kept in archive for a minimum of 2 years**

*NOTE* Examples of such documents are an operating procedure, a work instruction, or an approved blank record template.

**4.9.4** The composter shall maintain records that demonstrate effective control of production, storage and dispatch of composts.

**4.9.5** The records shall be:

- a) legible;
- b) genuine;
- c) collated and maintained such that they are readily retrievable; and
- d) stored in good condition for at least five years.

*NOTE* Specific record types to be established and information types to be recorded in them is specified within other clauses in this PAS, in connection with the activity to be recorded.

#### **4.10 Complaints and concerns**

**4.10.1** The composter shall **develop a procedure for dealing with complaints which shall detail** any necessary action in response to any complaints or concerns expressed by interested parties, including operatives, customers, clients and regulatory authorities about quality or usability of the compost.

**4.10.2** The composter shall record the:

- a) name and contact details of the person who expressed concern or made a complaint;
- b) specific subject(s) of the concern or complaint;
- c) date and time communicated to the composter and name of the person to whom it was communicated;
- d) nature and date(s) of any actions and checks and who carried them out;
- e) nature and date of any response to the person who expressed a concern or made the complaint; and
- f) name of the person who communicated the response.

#### **4.11 Internal audit of the QMS**

**4.11.1** At planned intervals of at least once per year, the producer shall audit the QMS to determine whether it:

- a) conforms to the QMS plan for production of compost that is fit-for-purpose (as defined in the quality policy); and

b) is effectively implemented and maintained.

**4.11.2** When planning the audit programme, the composter shall take into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits. The audit criteria, scope, frequency and methods shall be defined. Selection of auditors and conduct of audits shall ensure objectivity and impartiality of the audit process. Each auditor shall not audit his/her own work. **Each auditor shall be trained commensurate with his/her duties.**

**4.11.3** A documented QMS procedure shall define the responsibilities and requirements for planning and conducting audits, and for reporting results and maintaining records.

**4.11.4** The management responsible for the area being audited shall ensure that actions are promptly taken to eliminate any detected non-conformities and their causes. Follow-up activities shall include verification of the actions taken and reporting of verification results.

#### **4.12 Management review of the QMS**

**4.12.1** The composter's senior management shall review opportunities for improvement and the need for changes to the QMS, including the quality policy and HACCP plan.

**4.12.2** A formal, recorded review shall be undertaken at least once per year, or sooner than scheduled if triggered by change (see Note and **4.10.5**) before the scheduled date.

*NOTE The following are examples of types of change that should trigger a review:*

a) input material types;

b) industrial plant;

c) temperature monitoring system (in its design and/or nature of the equipment used, rather than replacement of an item of equipment with another item of the same make and model number;

c) staff levels and/or responsibilities;

d) customers' requirements in terms of compost quality;

f) legislation, codes of practice or other requirements to which the composter subscribes in the country of production or, where appropriate, the country or countries in which the compost is intended to be used.

**4.12.3** Inputs to each review shall include information on:

- a) results of QMS audits by the composter's personnel and any external auditors;
- b) any complaints and concerns expressed by interested parties, including operatives, customers, clients and regulatory authorities;
- c) composting process performance;
- d) compost quality (i.e. conformance of relevant grades to the quality policy, including fitness for purpose);
- e) status of preventive and corrective actions;
- f) follow-up actions from previous management reviews;
- g) changes that could affect the QMS; and
- h) recommendations for improvement.

*NOTE All elements of the QMS do not have to be reviewed at the same time. The review process may be iterative and take place over a period of time. The review should assess the continuing suitability of the QMS in relation to changing conditions and information.*

**4.12.4** The output from the management review shall record any decisions and actions related to:

- a) improvement of the efficacy of the QMS and its processes;
- b) improvement of compost quality as per customer requirements; and
- c) resource needs.

**4.12.5** If any **significant** non-temporary change occurs that affects compost quality, or if a non-temporary change in the required quality of compost occurs, the production process shall be re-validated (see **4.5**). In the event of temporary change(s) of this kind, the composter shall sample and test the relevant compost grade(s) as appropriate for determining the effects of any such temporary change(s) on compost quality.

**The significant and temporary or non-temporary nature of any change the producer is aware of shall be reviewed and recorded, the record including the producer's justification for each decision.**

*NOTE* Types of change that affect compost quality are a matter of judgement, so are not specified in this PAS. If the composter has applied to a certification body for initial or renewal certification, an interpretation of the certification scheme rules can be sought.

## **5 Input materials and composting process additives**

### **5.1 Input materials and checks**

**5.1.1** Input materials to the composting process shall be source segregated biowastes and/or source segregated biodegradable materials. Care shall be taken to avoid any potentially polluting wastes, products or materials from becoming included with the input materials.

**5.1.2** Sewage, any derivatives from it, or any mixture of materials that contains sewage or any derivatives from it shall not be allowed as input materials to the composting process.

**5.1.3** Packaged former foodstuffs, catering wastes, other types of Animal By-product (ABP) and non-ABP food wastes shall only be fed into the composting process if they comply with the composter's relevant input materials acceptance criteria (see **6.1.7**). If such biowastes are delivered for processing but include packaging that does not comply with the requirements in **6.1.4**, a pre-composting treatment step shall remove any non-biodegradable packaging prior to feeding those biowastes into the composting process.

**5.1.4** Biodegradable polymers, bags, packaging or other products made of such material shall be allowed as input materials to the composting process if they conform to the criteria within BS EN 13432, BS EN 14995, ASTM D6400.

*NOTE* Attention is drawn to the fact that the general public frequently expresses greater confidence in conformance with standards that are independently assessed by a third party, i.e. a certification body.

**5.1.5** Wood- and wood-derived wastes impregnated with preservatives, painted, or with any non-biodegradable layer shall not be allowed as input materials to the composting process.

**5.1.6** The composting process may include as an input, digestate, either resulting from:

- a) an anaerobic digestion process conforming to PAS 110; or
- b) an anaerobic or aerobic digestion process using only input materials specified in PAS 100.

*NOTE 1 "Digestate" includes whole digestate, separated fibre and separated liquor fractions. The authorization for the composting facility would include provisions for control of emissions associated with use of liquid or pumpable forms of digestate and their storage. If in future PAS 110 includes TAD within its scope and the digestate from such a process complies with PAS 110, the digestate would be an eligible input material to a PAS 100 composting process.*

*NOTE 2 There are currently some differences between the input materials allowed under the Compost QP and the AD QP. If compost is used as a product in any country in which Compost QP compliance applies, if its input materials have included digestate, the digestate can only have been made from input materials allowed under the AD QP [b].*

*NOTE 3 Digestate from an anaerobic or aerobic digestion process that complies with EU Regulation 1774/2002/EC [21] as amended [22], or the relevant national Animal By-Products Regulation if catering waste [23, 24, 25 or 26] , is considered as non-ABP material if subsequently composted.*

**5.1.7** The composteer's appropriate QMS document(s) shall state criteria for the acceptance of input materials and rejection of unsuitable wastes/materials, based on the HACCP plan. The criteria shall also require the input material supplier to demonstrate that all practicable measures have been taken to prevent contamination of input materials with unsuitable wastes/materials.

*NOTE The composteer needs to have an understanding of the types of contaminants and odours that could be associated with different input material types and sources. The composteer is responsible for ensuring the criteria are effective and practicable, and making each input material supplier aware of the specific acceptance/rejection criteria and obligation to demonstrate prevention of contamination.*

**Attention to exclusion of sharps (see definition of term 3.64) and minimization of the associated risks is particularly important [see 5.1.1 item h) and Table 3's item 12 and its Notes a), d) and e)]. Any contractual arrangement between the composteer and an input material supplier should contain provisions that enable the composteer to i) charge a higher gate fee for any delivery that needs clean up before being accepted for composting, or ii) refuse or reject any delivery that is too contaminated for clean up.**

**5.1.8** For each load of input material delivered, the composteer shall make and keep a record of the:

- a) input material type(s) and its/their List of Wastes code(s) (see [16] for England, [17] for Wales, [15] for Scotland, and [18] for Northern Ireland);
- b) source;
- c) quantity;
- d) date delivered; and
- e) delivery location on site.

*NOTE Requirement e) does not apply if there is only one delivery location and one composting process at the site, and both are identified in the operating procedures, or elsewhere in the composteer's QMS documentation.*

**5.1.9** Each delivery of input material shall be inspected at a location where there is adequate control of risk of cross-contamination between the delivered load and any input materials accepted for composting, materials undergoing composting or fully composted materials in storage.

*NOTE Inspection should be carried out soon after the load has been discharged from the transport vehicle, as appropriate to the facility layout and its composting system. Inspection activities should be sufficient to verify whether the load is within the CLs in the composteer's acceptance criteria. QMS activities include checking that the CLs are effective.*

**5.1.10** For each of any input material load or part-load rejected after delivery, the composteer shall make and keep a record of the:

- a) input material type(s) and its/their List of Wastes code(s) (see [16] for England, [17] for Wales, [15] for Scotland, and [18] for Northern Ireland);
- b) source;
- c) quantity;

- d) date rejected;
- e) reason for rejection; and
- f) to whom it was sent.

*NOTE Periodically, container loads of physical contaminants removed from numerous accepted input material deliveries, are sent to a disposal facility. The sources of the physical contaminants and reason for rejection do not have to be recorded for those container loads because the sources are many and the material is rejected because it consists of physical contaminants.*

## **5.2 Composting process additives**

**5.2.1** A composting process additive shall only be used if:

- a) it is intended to confer benefit to the composting process or reduce emissions;
- b) it is used during the sanitization step or during the first two weeks of the stabilization step;
- c) HACCP assessment and compost quality test results demonstrate that the compost is fit-for-purpose;
- d) the product is identified in the composter's appropriate QMS document together with instructions on its use or cross-reference to such instructions in another QMS document.

*NOTE The manufacturer's instructions for use should be followed but may be modified by the composter if such instructions conflict with good composting practice or specific instructions from the regulator or ABP competent authority. The proportion added to any batch of composting material should be a very low percentage, either on a mass per mass or volume per volume basis. The composter's HACCP assessment should take account of all applicable regulations with regard to use of the additive, and subsequent use of the compost if it contains any residue of the additive. Regulations that control fertilizers, animal health or the food chain may apply, dependent upon the specific additive chosen.*

## **6 Actively-managed composting**

**6.1** The input materials, the steps used to make the composts and their storage shall be kept separate from any other materials (inputs, outputs or by-products), processes and stores at the same site. The composting process shall be arranged such that compost that conforms to this PAS does not become contaminated, including when in storage after processing.

*NOTE The same principles apply to any product made by the composter that contains PAS 100 conforming compost.*

### **6.2 Composting batch formation**

**6.2.1** Composting batch formation procedures shall be stated in the composter's QMS document(s). For each batch, the composter shall record:

- a) activities carried out when forming it;
- b) formation start and finish dates; and
- c) the composting batch code assigned.

*NOTE 1 Examples of such activities are shredding, mixing, wetting, partial drying or addition of composting process additives.*

*NOTE 2 A composting process operated fully, or partially, on a plug-flow or continuous flow basis may refer to a "portion of production" instead of a "batch" (see 3.20). Throughout this PAS, "batch" may be interpreted as "portion of production". A mass balance approach that takes account of composting process throughput rates (input tonnage and weight reduction over a known period of time) can be used to allocate and trace each portion of production.*

### 6.3 Sanitization

*NOTE Where 7.1.1 to 7.1.7 use the words “composting batch” this should be read as “aerobically digesting batch” if the system uses TAD for the sanitization step instead of thermophilic aerobic composting (see 3.19).*

**6.3.1** Each composting batch shall undergo an identifiable sanitization step, in accordance with the HACCP plan and SOPs.

*NOTE This step is CCP for pathogen risk control. Attention is drawn to statutory requirements for sanitization of animal by-products (see [21] as amended by [22], or the relevant Animal By-Products Regulation if catering waste [23], [24], [25] or [26]) and guidance on managing plant health risks (see Annex B and references [k] and [l]). See 3.57 for the definition of sanitization and 3.10 and 3.11 respectively for the definitions of “catering waste, meat excluded” and “catering waste, meat included”.*

**6.3.2** CL parameters, derived from the HACCP plan, shall include:

- a) temperature (see Clause 8, Table 1 and Annex B);
- b) a minimum amount of time during which composting batch temperature is within its CL range;

*NOTE In the case of sanitization by means of windrow turning, the minimum amount of time can comprise a number of shorter time periods, i.e. those between each turn of the windrow (see Annex B). This allows for temporary temperature drops that occur when turning a windrow. If composting ABPs using a housed windrow composting system, refer to the relevant parts of the ABP regulations. The ABP approval issued by the competent authority includes specific temperature monitoring requirements. The same guidance applies to any composting system that is not turned windrow but which requires periodic mixing or turning of each batch of compost in order that each one undergoes the sanitizing conditions for sufficient time.*

- c) moisture (see Clause 8, Table 1 and Annex B); and
- d) turning/mixing if this is necessary for exposing the entire composting batch to the sanitizing conditions (see Annex B).

**6.3.3** The composter's appropriate QMS document(s) shall state:

- a) routine procedures for managing, monitoring, recording and evaluating each composting batch in this step;

*NOTE As applicable, this may cover watering, mixing/turning frequency or programme of pumped aeration.*

- b) the CLs for each sanitization parameter (see 7.1.3 and Annex B which provides guidance on achieving sanitization);
- c) corrective action options for when monitoring results and composting batch management records show that a CL result is outside its CL;
- d) measures that will be taken if corrective action fails to bring one or more of the CL parameters within corresponding CLs (see Clause 15); and
- e) procedures in the event of system or equipment failure.

**6.3.4** Each composting batch shall be monitored during sanitization in accordance with Clause 8, and the monitoring results shall be recorded.

**6.3.5** The composter shall apply an appropriate corrective action to any composting batch where evaluation of monitoring and management records for that batch show that any CL result went outside its CL(s).

**6.3.6** The composter shall only pass the composting batch as sanitized if the monitoring and management record shows that it has complied with the CLs for this CCP.

**6.3.7** If any input material is added to a composting batch after it has completed its sanitization step, it shall undergo an additional sanitization step. The input material addition, results of monitoring and outcome of the additional sanitization step shall be recorded on the composting batch record. If input material is routinely added to composting batches after they have completed their initial sanitization step, the composter shall include the additional sanitization step and the CLs of this CCP in his/her appropriate QMS document(s).

#### **6.4 Stabilization**

**6.4.1** Each composting batch shall undergo an identifiable stabilization step, in accordance with the HACCP plan and SOPs.

*NOTE 1* The minimum sanitization period is designated by the composter, having considered the input material types, the management of the whole composting process and control of the composting conditions.

*NOTE 2* Vermi-composting may be used during stabilization and any maturation step thereafter.

**6.4.2** CL parameters, derived from the HACCP plan, shall include:

- a) temperature (see Clause 8, Table 1 and Annex B);
- b) a minimum amount of time during which composting batch temperature is within its CL range;

*NOTE* In the case of stabilization by means of windrow turning, the minimum amount of time can comprise a number of shorter, non-consecutive time periods. This allows for temporary temperature drops that occur when turning a windrow.

- c) moisture (see Clause 8, Table 1 and Annex B); and
- d) turning/mixing if this is necessary for achieving consistent stabilization throughout the composting batch.

**6.4.3** The composter's appropriate QMS document(s) shall state:

- a) routine procedures for managing, monitoring, recording and evaluating stabilization of each composting batch;
- b) the CLs for each stabilization parameter;
- c) corrective action options for when monitoring results and composting batch management records show that a CL result has gone outside its CL;
- d) measures that will be taken if corrective action fails to bring the results of any CL parameter within its corresponding CLs (see Clause 15); and
- e) procedures in the event of system or equipment failure.

**6.4.4** Each composting batch shall be monitored during this step in accordance with Clause 8, and the monitoring results shall be recorded.

**6.4.5** The composter shall apply the appropriate corrective action to any composting batch where evaluation of monitoring and management records for that batch shows that any CL result went outside its CL(s).

**6.4.6** The composter shall only pass the composting batch as stabilized if the monitoring and management record shows that it has complied with the CLs for this CCP.

**6.4.7** If any composting batches are combined during stabilization, the corresponding records shall include the codes of the combined batches and the overall code assigned to the combined batches.

## 7 Monitoring

7.1 Composting process monitoring shall not be less than that specified in Table 1.

<b>Table 1 – Minimum composting process monitoring</b>	
<b>Sanitization step</b>	<b>Stabilization step</b>
<b>Aerobic composting: enclosed, in-vessel, or insulated aerated static piles</b> a)	<b>Aerobic composting: enclosed, in-vessel, or insulated aerated static piles</b> a)
Temperature monitoring frequency and locations in accordance with the approval from the competent authority if treating ABPs OR composter's HACCP assessment <sup>d)</sup> & <sup>e)</sup> if not treating ABPs	Temperature monitoring once per week, locations in accordance with the composter's HACCP assessment <sup>d)</sup> & <sup>e)</sup> , whether treating ABPs or not
Moisture <sup>c)</sup> monitoring frequency and locations in accordance with the composter's HACCP assessment <sup>d)</sup> & <sup>e)</sup> , whether treating ABPs or not	Moisture monitoring <sup>c)</sup> once per week, locations in accordance with the composter's HACCP assessment <sup>d)</sup> & <sup>e)</sup> , whether treating ABPs or not
<b>TAD</b>	<b>TAD</b>
Temperature monitoring frequency and locations in accordance with the approval from the competent authority if treating ABPs; OR composter's HACCP assessment <sup>d)</sup> & <sup>e)</sup> if not treating ABPs	This type of treatment not allowed for stabilization step (see PAS 100 scope)

Moisture monitoring not required as level required for pumping in and out of digestion vessel sufficient for sanitization purposes	
<b>Outdoor turned windrow <sup>h)</sup></b>	<b>Outdoor turned windrow <sup>h)</sup></b>
Temperature monitoring once per working day <sup>g)</sup> , locations: 3 in core zone of batch if its total volume < 750 m <sup>3</sup> OR 1 in core zone per 250 m <sup>3</sup> of batch if its total volume ≥ 750 m <sup>3</sup> Temperature monitoring points not required in surface and base zones	Temperature monitoring once per week, locations: 3 in core zone of batch if its total volume < 750 m <sup>3</sup> OR 1 in core zone per 250 m <sup>3</sup> of batch if its total volume ≥ 750 m <sup>3</sup> Temperature monitoring points not required in surface and base zones
Moisture <sup>c)</sup> monitoring once per working day <sup>g)</sup> , locations in accordance with the composter's HACCP assessment <sup>e)</sup> .	Moisture <sup>c)</sup> monitoring once per week, locations in accordance with the composter's HACCP assessment <sup>e)</sup> .
<b>Aerated static piles, uninsulated <sup>h) &amp; i)</sup></b>	<b>Aerated static piles, uninsulated <sup>h) &amp; i)</sup></b>
Temperature monitoring once per working day <sup>g)</sup> , locations: 3 in each of core, surface and base zones of batch if its total volume < 750 m <sup>3</sup> OR 1 in core zone, 1 in surface zone and 1 in base zone per 250 m <sup>3</sup> of batch if its total volume ≥ 750 m <sup>3</sup>	Temperature monitoring once per week, locations: 3 in each of core, surface and base zones of batch if its total volume < 750 m <sup>3</sup> OR 1 in core zone, 1 in surface zone and 1 in base zone per 250 m <sup>3</sup> of batch if its total volume ≥ 750 m <sup>3</sup>
Moisture <sup>c)</sup> monitoring once per working day <sup>g)</sup> , locations in accordance with the composter's HACCP assessment <sup>e)</sup>	Moisture <sup>c)</sup> monitoring once per week, locations in accordance with the composter's HACCP assessment <sup>e)</sup>

- <sup>a)</sup> Includes housed windrows (i.e. those enclosed within a building).
- <sup>c)</sup> Annex B provides recommendations on moisture level and monitoring.
- <sup>d)</sup> Monitoring is to be carried out within the composting mass in the vessel/enclosed space or at the validated components of the system appropriate for monitoring the performance of the process step. Health and safety considerations affect the locations of monitoring points.
- <sup>e)</sup> The HACCP assessment should consider spots/pockets within the composting mass that could be colder than its hottest zone or drier than its moistest zone.
- <sup>f)</sup> A working day is any day when staff work on site.
- <sup>g)</sup> Where a composting system uses an outdoor sanitization or stabilization step, weather conditions should be regularly monitored and recorded. Relevant parameters are wind speed and direction, precipitation and ambient temperature. These parameters influence composting batch temperature and moisture and may be taken into account when assessing the need for corrective action on any batch and evaluating composting process performance.
- <sup>h)</sup> Outdoor aerated static piles: If any composting batch is turned/mixed two or more times during its sanitization phase, it should be monitored as required in Table 1 for sanitization of outdoor turned windrows. If any composting batch is turned/mixed three or more times during its stabilization phase, it should be monitored as required in Table 1 for stabilization of outdoor turned windrows.

**7.2** The composter's appropriate QMS document(s) shall state typical batch size together with expected maximum and minimum batch sizes. In the case of any composting step that utilizes outdoor turned windrows or uninsulated aerated static piles, the composter's appropriate QMS document(s) shall also include a diagram and/or description of composting batch surface, core and base zones, as appropriate to typical batch size (in tonnes or m<sup>3</sup>).

**7.3** The composter's appropriate QMS document(s) shall:

- a) state the routine frequency and procedure for checks on the temperature monitoring system, those carried out by the composter and any carried out by an organization independent of the composter;
 

*NOTE It is recommended that a calibration check is carried out by a third party, i.e. a calibration service provider, at least once per year.*
- b) commit to taking immediate corrective action when any part of the temperature monitoring system causes inaccurate temperature data, with re-check of the affected part of the system immediately following completion of the corrective action; and
- c) record data obtained during each calibration check on the temperature monitoring system, and record details of any repairs or adjustments undertaken and the outcome (and obtain such records if the check is carried out by an organization independent of the composter).

*NOTE 1 Temperature monitoring systems can range from a number of hand-held temperature probes and sensors associated with manual recording of temperature readings, to complex ones that utilize multiple temperature sensors read by computers.*

*NOTE 2 A certificate of calibration from an organization that carries out independent calibration checks might not include all key data. Each time such an organization carries out a calibration check, its assessor should supply the composter with a record of the key data and evaluation in connection with the written method statement. Such records form part of the composter's QMS records.*

## 8 Product preparation

**8.1** The composter's appropriate QMS document(s) shall state product preparation procedures, as applicable to the compost grade and any product that includes such compost as an ingredient.

*NOTE* Product preparation could involve but is not limited to:

- a) screening to create one or more compost grades (in terms of particle size range) and/or remove any physical contaminants;
- b) blending with other permitted materials, PAS 100 composts, products, or additives; and/or
- c) increase or reduction of moisture content.

*A grade of compost may be used as more than one type of product and/or in more than one type of product. If PAS 100 compost is blended with any controlled waste, those blended materials are "controlled waste" and will be regulated accordingly.*

**8.2** The composter shall record how and when product preparation is carried out on each composted batch that undergoes this production step.

*NOTE* The record for a composted batch normally includes start and finish dates of screening and the screen's aperture size(s).

**8.3** If compost, or a product containing it that is made on behalf of the composter, is packaged at a location different from the composting facility, the composter's appropriate QMS document(s) shall include:

- a) the name and contact details of the person or organization that carries out the activity; and
- b) a description of the activity and which compost grade(s) it applies to.

## 9 Maturation

**9.1** Maturation is an optional step that can apply to one or more compost grades. The composter's appropriate QMS document(s) shall state each compost grade to which maturation applies, the corresponding CLs of this step, and whether it is carried out before or after product preparation. Maturation CLs are not required to be the same for each compost grade, but shall be clearly stated in connection with the corresponding compost grade.

*NOTE 1* Compost for use as a growing medium ingredient or other product to be packed and stored, should be matured to ensure it is sufficiently biodegraded. References ORG 0020 (see Clause 2) and [m] (see bibliography's references to 'documents that are not legislation') provide guidance on test parameters, methods and limits.

*NOTE 2* Maturation can be carried out before or after product preparation (see Clause 9), as appropriate to the production process for the compost grade(s). CL examples for the maturation step are a minimum period of time that each composting batch of the relevant compost grade undergoes maturation, or the sampled compost's stability test result having fallen below the composter's specified maturation level for the compost grade.

**9.2** Monitoring of composting conditions during maturation is optional. If monitoring is carried out the composter's appropriate QMS document(s) shall state the CLs for any parameters monitored and the monitoring regime.

*NOTE* Composting batch core zone average temperature is an example of a relevant parameter. The results should show a downward trend during maturation and can be used to assess when the composting batch's core zone average temperature falls below a suitable minimum for the compost grade, as set by the composter (in the appropriate QMS document) according to customer requirements.

**9.3** For each composting batch that undergoes maturation, a record of any CL parameter monitoring or sample test results shall be made, and shall include the date on which the batch achieved maturation.

**9.4** The composter shall only pass each composting batch that has undergone maturation as “mature”:

- a) if the monitoring and management record shows that the composting conditions and batch management were maintained within the validated CLs, including any CL for the maturation step applicable to the compost grade; or
- b) by taking a representative sample of the composting batch and establishing that the test result conforms with the maturity criteria stated in the composter’s appropriate QMS document for that compost grade.

**9.5** If any composting batches are combined during maturation, the corresponding records shall include the codes of the combined batches and the overall code assigned to them.

## **10 Product storage**

**10.1** The composter’s appropriate QMS document(s) shall describe provisions for storage of compost and any products containing it, prior to their dispatch. The described provisions shall cover:

- a) the storage location for each compost grade and whether outdoor, indoor or covered;
- b) compost batch identification;
- c) how contamination of compost is prevented; and
- d) identification of any product(s) that contain compost and their storage location(s).

**10.2** Compost/product batches shall be identifiable when in storage (see also **18.3**).

## **11 Compost sampling**

**11.1** Any batch of the composter’s principal compost grade selected for sampling and testing shall be sampled and sent for testing:

- a) during the week after the batch has completed the minimum composting process applicable to the grade (including a maturation step if applicable);
- b) after particle size screening, if applicable [see Note to **9.1 item a**]; and
- c) before any blending with wastes, materials, composts, products or additives.

The requirements of this clause also apply to any additional compost grade for which PAS 100 conformity is claimed, or intended to be claimed [see **4.2 item b**].

*NOTE Some compost properties could change during storage due to on-going, low level biodegradation. If appropriate according to customer needs/quality specification, the composter should sample and test compost stored for a considerable period of time in terms of parameters that could have significantly different results. If PAS 100 compost is blended with any controlled waste, those blended materials are “controlled waste” and will be regulated accordingly.*

**11.2** Any sample taken and tested for ABP Regulation purposes, [see 21 as amended by 22] or if catering waste [23 for England], [24 for Wales], [25 for Scotland] or [26 for Northern Ireland], shall only be included when evaluating compliance with this PAS if the sample is:

- a) taken as required in Clauses 12 and 13; and
- b) tested as required in Clauses 12.6 to 12.7 and 14, and with regard to parameters *E. coli* and *Salmonella* spp, in accordance with the methods of test specified in Table 3 and subject to the upper limits specified in Table 3.

*NOTE* An ABP composting material sample taken during or at the end of the ABP sanitization step is NOT a suitable time to take a sample for PAS 100 testing and compliance checking purposes. The test results of any sample taken during this time are not acceptable evidence that the fully processed compost is fit-for-purpose.

**11.3** Each sample shall be representative of the compost batch from which it is obtained.

*NOTE* BS EN 12579 provides guidance about how to obtain a representative sample of compost from a batch. The maximum batch size from which the representative sample is derived should be appropriate to the system, test results history for the compost grade and the intended customer's supply requirements. The statistically valid number of sub-samples to take from the batch and then be thoroughly mixed is given by formula:  $n_{sp} = 0.5 (V^{1/2})$ , where V is the volume of the batch sampled. A minimum of 12 and a maximum of 30 sub-samples apply. Thus for a batch sized 250 m<sup>3</sup> or 500 m<sup>3</sup>, 12 sub-samples should be taken. For batches sized 1 000 m<sup>3</sup> and 2 000 m<sup>3</sup>, 16 and 22 sub-samples should be taken respectively. For a batch sized 3 600 m<sup>3</sup> or more, 30 sub-samples should be taken. To minimize any changes in compost properties, any archived samples should be kept in a dark, dry place where the temperature is less than 10 °C but not less than 1 °C.

**11.4** The composter's appropriate QMS document shall include the sampling procedure or refer to the published sampling procedure used.

**11.5** For each sample, the following information shall be included in the record kept by the composter:

- a) sampling date;
- b) compost grade (if screened, e.g. 0 mm to 25 mm);
- c) code of the batch from which the sample was taken;
- d) sample code (this can be the same as c);
- e) information that identifies the composting process;
- f) name of the person who carried out the sampling; and
- g) if the sample taker is not employed by the composter, on whose behalf the sample taker is acting and his / her contact details.

*NOTE* This applies to any sample taken by any party other than the composter, who records sampling and supplies information to the laboratory on the composter's behalf.

Each sample tested in order to demonstrate compliance with this PAS shall be witnessed or taken by an appropriate person, independent of the composter. Exemption from this requirement shall be allowed for samples taken for investigating the efficacy of the QMS in the event of a test result failure (see section 16)

**11.6** Each sample tested in order to demonstrate compliance with this PAS shall be sent to an appropriate laboratory within 1 working day after the sample was taken.

The laboratory shall be independent of the composter.

Sample transit shall be under cool conditions.

NOTE 1 For pathogen testing, sample receipt at the laboratory within 24 hours of sample taking is recommended. **Cool conditions refers to use of a cool box and ice pack**

11.7 The laboratory that receives the sample shall be informed of the information required in 12.5 items a), b), c), d) and e).

## 12 Minimum frequencies for compost sampling and testing

The principal compost grade shall undergo routine batch sampling and testing at the minimum frequencies specified in Table 2, according to whether the process is being validated or is operating after validation. Any additional compost grade for which PAS 100 conformance is claimed, or intended to be claimed [see 4.2 item b)] shall also undergo routine batch sampling and testing at the minimum frequencies specified in Table 2, according to whether the process is being validated or is operating after validation.

NOTE Validation means initial validation or revalidation.

Parameter <sup>a)</sup>	Minimum number of samples <sup>b)</sup>	
	Validation	After validation
Pathogens (human and animal indicator species)	1 sample from each of 3 different batches of the compost grade	1 sample representative of 1 compost batch amongst those comprising <b>5 000 m<sup>3</sup> / 2500 tonnes</b> of the compost grade produced. <b>An interval shall be kept between samples of a minimum of 2500m<sup>3</sup> / 1250 tonnes</b> O R if <b>&lt; 5 000 m<sup>3</sup> / &lt;2500 tonnes</b> of the compost grade is produced per 12 months, 1 sample representative of 1 compost batch
Potentially toxic elements		
Stability/maturity (microbial respiration rate)		
Physical contaminants and stones		
Plant response, weed seeds and propagules		

<sup>a)</sup> Annex C and documents referenced in the bibliography recommend optional, additional parameters as relevant to the compost/product type. Particle size distribution is always determined because it is part of the procedure for determining physical contaminant content and provides evidence about the “nominal particle size grade” that Clause 17 item b) requires to be declared in labelling.

<sup>b)</sup> Those who specify, supply and use compost can require more frequent sampling and testing than the minimum for each parameter in this table and sample testing for other market-specific parameters. The planned sampling and testing regime should be set out in the composter’s appropriate QMS document and be regularly checked and updated according to quantities of PAS 100 compost grades produced and whether any test results failure(s) has triggered extra batch sampling and testing (see Clause 16).

### 13 Minimum compost quality

**13.1** The tests specified in Tables 3 and 4 shall be performed on the principal compost grade (see 3.51) for which PAS 100 conformance is claimed, or intended to be claimed. Samples of that grade shall achieve the:

- a) minimum quality requirements in Table 3, and
- b) minimum plant response requirements in Table 4.

*NOTE See footnote a) to Table 3.*

**13.2** Each additional compost grade for which PAS 100 conformance is claimed, or intended to be claimed [see 4.2 item b)], shall undergo the tests specified in Table 3 and achieve the corresponding minimum quality requirements set in Table 3, except for the weeds test and its upper limit (see item 11). Each such grade shall also be exempt from the plant response test, minimum response level and absence of abnormalities criteria specified in Table 4 (see items 1, 2 and 3).

**13.3** Exemption from Table 3 item 10's stability test and upper limit for stability shall be allowed for an additional compost grade if it consists of particles too coarse to pass through a screen with 20 mm apertures (whether square, round or other shaped apertures).

*NOTE An example is a coarse mulch grade of compost derived from particles that have passed through a screen with 40 mm apertures, from which most particles smaller than 20 mm are removed by passing through a screen with 20 mm apertures. Such a grade would have a nominal particle size range of 20 mm to 40 mm. If stability tested, its result is expected to be very low and certainly lower than stability results for any compost grade with a higher proportion of particles smaller than 20 mm, such as a 0 mm to 40 mm soil conditioning grade.*

**13.4** If the composter chooses to apply the stones limit specified in item 13b instead of the limit in item 13a in Table 3 to any coarse, woody compost grade, the composter shall describe that grade only as a "mulch" (see 3.48) in labelling and when placing it on the market, and instruct its use only as a mulch.

*NOTE Table 3, item 13b's 10 % upper limit for stones is for coarse, woody mulches derived by screening composted material, for example a 10 mm to 40 mm grade or a 20 mm to 40 mm grade. It is not intended for a soil conditioning grade such as a 0 mm to 40 mm soil conditioner supplied for use in agriculture or other markets.*

Table 3 – Minimum compost quality for general use				
Item	Parameter	Method of test	Unit	Upper limit <sup>a)</sup>
Pathogens (human and animal indicator species) <sup>b)</sup>				
1	<i>Escherichia coli</i>	BS ISO 16649-2	CFU / g fresh mass	1000
2	<i>Salmonella</i> spp	Schedule 2, Part II of BS EN ISO 6579.	25 g fresh mass	Absent
PTEs				
3	Cadmium (Cd)	BS EN 13650 (soluble in aqua regia)	mg / kg dry matter	1.5

4	Chromium (Cr)	BS EN 13650 (soluble in aqua regia)	mg / kg dry matter	100
5	Copper (Cu)	BS EN 13650 (soluble in aqua regia)	mg / kg dry matter	200
6	Lead (Pb)	BS EN 13650 (soluble in aqua regia)	mg / kg dry matter	200
7	Mercury (Hg)	BS ISO 16772	mg / kg dry matter	1.0
8	Nickel (Ni)	BS EN 13650 (soluble in aqua regia)	mg / kg dry matter	50
9	Zinc (Zn)	BS EN 13650 (soluble in aqua regia)	mg / kg dry matter	400
Stability/maturity <sup>c)</sup>				
10	Microbial respiration rate	ORG 0020	mg CO <sub>2</sub> / g organic matter / day	16/ 20
Weed seeds and propagules				
11	Germinating weed seeds or propagule regrowth	OFW004-006	mean number / litre of compost	0
Physical contaminants				
12	Total glass, metal, plastic and any 'other' non-stone fragments > 2 mm	AfOR MT PC&S <sup>d)</sup>	% mass / mass of "air-dry" sample	0.25 <sup>d)</sup> , of which 0.12 is plastic
Stones				
13a	Stones >4 /10 mm in grades other than "mulch"	AfOR MT PC&S	% mass / mass of "air-dry" sample	8
13b	Stones > 4 /10 mm in "mulch" grade			10
<p><sup>a)</sup> Composts for some end uses might have to achieve quality characteristics that are more stringent than those in Table 3 or cover a wider range of parameters.</p> <p><sup>b)</sup> <i>Salmonella spp</i> and <i>Escherichia coli</i> (<i>E. coli</i>) are commonly used indicator</p>				

species for human and animal pathogens.

<sup>c)</sup> WRAP's 'Guidelines for the specification of quality compost for use in growing media' [m] include recommendations on additional tests, associated limits and target values for mature composts.

<sup>d)</sup> Physical contaminants that are "sharp" (see 3.64) are unacceptable in any application where compost is bagged or supplied for any use where it is handled without protective gloves.

**Table 4 – Minimum plant response**

Item	Parameter	Method of test	Unit/observation	Minimum response
1	Tomato plant germination	OFW00 4-006	Germinated plants in peat-compost test mix trays as % of germinated plants in peat control trays	80 <sup>a)</sup>
2	Tomato plant growth	OFW00 4-006	Average plant mass in peat-compost test mix trays as % of average plant mass in peat control trays	80 <sup>a)</sup>
3	Tomato plant abnormalities	OFW00 4-006	Plants grown in peat-compost test mix trays: description of any abnormalities	No abnormalities <sup>b)</sup>

<sup>a)</sup> The method of test instructs that if germination of tomato plants or average tomato plant mass in the peat control trays is lower than the specified, respective minimum levels the test is invalid. Any invalid test result is not taken into account when evaluating conformance to this PAS.

<sup>b)</sup> The method of test instructs that any abnormalities are described in the laboratory's report of the test results. Abnormalities that are exerted by the compost-peat test mix in any tray, can be regarded as a sample test fail result, even if germination and average tomato plant mass results are at or above the minimum response levels specified in Table 4, items 1 and 2. Any abnormalities exerted by the peat in any control tray invalidate the test.

**NOTE** The method for testing field bean germination and growth response is recommended for samples from compost batches destined for use as growing media.

## 14 Non-conforming material

**14.1** Any composting batch that does not undergo all applicable CCPs or conform to one or more of the CLs applicable to a CCP shall:

- a) undergo corrective action then be evaluated for conformance to the composter's relevant CCP and CL criteria;
- b) undergo recomposting with or without addition of further input material as appropriate, then be evaluated for conformance to the composter's relevant CP and CL criteria; or
- c) be dispatched from the site for use, processing elsewhere or disposal, and the recipient notified of its PAS 100 non-conformity as well as the nature of the non-conformity.

**14.2** Any sampled and tested compost batch that does not conform to the minimum quality and plant response requirements specified in Clause **14** (as applicable to the grade) plus any additional criteria applicable to the compost grade [in accordance with the composter's quality policy, see Clause **4.2** item d)] shall:

- a) undergo corrective action then be sampled and tested in terms of the parameter(s) relevant for evaluating efficacy of the corrective action;
- b) undergo recomposting with or without addition of further input material as appropriate, then be sampled and tested in terms of the parameter(s) relevant for evaluating efficacy of the corrective action; or
- c) be dispatched for use, processing elsewhere or disposal, and the recipient and regulator notified of the nature of its non-conformity with PAS 100.

**14.3** The composter shall take action appropriate to the nature of the non-conformity and record the action(s) applied to the affected composting/compost batch.

*NOTE 1 In the case of any non-conforming compost dispatched and intended for an application covered by the Environmental Permitting Regulations [8] or Waste Management Licensing Regulations (see [1] and [10] for Scotland or [12] for Northern Ireland) the regulator will expect the composter to carry out all relevant actions required by the regulations. Such actions are likely to be those applicable to material with 'waste' status.*

*NOTE 2 The oversize, coarse woody particles that arise when screening compost can be dispatched for disposal, supplied for use as non-PAS 100-conforming material, or reprocessed if physical contamination is low or is reduced before reprocessing.*

*NOTE 3 ABP Regulations prohibit the spreading on land of any ABP-derived compost batch that contains any pathogen indicator species at a concentration above its corresponding limit set in the relevant ABP Regulations [21] as amended by [22], or if derived from catering waste [23], [24], [25] or [26]. Composters should refer to the competent authority or its most up-to-date written guidance on options for on-site management or dispatch from site of any such failed compost batch.*

### 14.4

Option 1 – No sampled batch shall be dispatched for use until after the test results have been checked for conformance to PAS 100.

or

**Comment [BB2]: NOTE TO REVIEWER: CONSIDER WHICH OPTION IS PREFERRED – PLEASE STATE YOUR PREFERENCE**

**Option 2** - After validation, if any compost batch sampled for testing is dispatched from the composting site with claim of PAS 100 conformance before its test results have been reported and evaluated, then later when its test results are reported (by the laboratory) and evaluated (by the composter) the batch is found to have failed (on any applicable aspect of quality in accordance with Clause 14), the composter shall inform the compost customer and the regulator of the nature of the failure.

*NOTE 1 Any composted controlled wastes that do not conform to this PAS, and the Compost QP in any country in which it applies, could have 'waste' status. Evidence would be reviewed and a "waste" or "product" status decision made by the regulator. If "waste", its transportation, storage and use after dispatch would be subject to waste regulatory controls. Results from any further test(s) on a sample from the same batch can be taken into account when deciding whether waste regulatory controls apply or enforcement action should be taken. Consequently, it is strongly recommended that, even after validation, any sampled batch is NOT dispatched for use until after the test results have been checked for conformance to PAS 100.*

*NOTE 2 The ABP Regulations, in effect, require any compost batch sampled and tested for ABP Regulation purposes to be kept at the composting site until its test results have been evaluated. The compost batch may only be dispatched for spreading on land if its test results show that it does not contain any pathogen indicator species at a concentration above its corresponding limit set in the relevant ABP Regulations [21 as amended by 22], or if derived from catering waste [23], [24], [25] or [26].*

## **15 Investigating the efficacy of the QMS in the event of a test result failure after validation**

**15.1** After validation, if a tested compost sample fails any minimum quality and plant response requirement in Tables 3 and 4 applicable to the compost grade (see Clause **14**), the composter shall investigate why it happened and decide whether the QMS needs to be changed. If it does, the composter shall implement the change and evaluate its effects (see **16.2**). If it does not, the composter shall implement a corrective action and evaluate its effects (see **16.3**). The same actions shall be carried out if a compost sample fails any additional criteria the composter has subscribed to in his/her quality policy, applicable to the compost grade. The actions of the investigation, the investigation period and its outcome shall be recorded. The actions required in this clause shall be carried out without delay, in response to the failure.

*NOTE 1 For example, change to the input materials or compost production process might not be needed if the failure occurred because an item of monitoring equipment was faulty but has since been replaced or repaired and checked. Similarly, a lapse in control at a CCP or incorrect assessment of control of the system could occur due to error by an individual worker. In this scenario the worker should promptly undergo further training and then performance evaluation. However, a change to the input materials or the compost production process would be necessary if the batch that failed was produced according to the validated "under control" QMS (meaning that all of the batch underwent each CCP relevant to the compost grade, that each CCP was controlled within its CLs, that none of the monitoring equipment used was faulty, no mistakes were made in recording and evaluating production information and no contamination occurred after the batch completed its production process).*

**15.2** If the QMS is changed, extra batch(es) of the compost grade produced according to the changed QMS shall be sampled and tested. The test parameter(s) and number of extra batches of the compost grade that are sampled and tested shall be appropriate to the nature of the failure and sufficient for checking the efficacy of the change.

**15.3** If corrective action is implemented (rather than change to the QMS), extra batch(es) of the compost grade shall be sampled and tested after the corrective

action has been implemented. The test parameter(s) and number of further batches of the compost grade that are sampled and tested shall be appropriate to the nature of the failure and sufficient for checking the efficacy of the corrective action.

*NOTE Examples of corrective action are repair and re-calibration of an item of monitoring equipment and re-training the person(s) responsible for checks on monitoring equipment.*

## 16 Labelling and marking

16.1 The following information about each consignment of PAS 100 conforming compost dispatched shall be printed on packaging or on a separate document supplied to the compost recipient:

- a) product type; mulch, soil improver, topsoil (manufactured), turf dressing, growing medium, or other specified by the composter;
- b) nominal particle size grade (e.g. "Grade: 0 mm to 10 mm particles");
- c) quantity and unit of measure (e.g. in litres, cubic metres, kilograms or tonnes);

*NOTE If sold by weight, compost moisture content should be declared (as % mass/mass or g/l), as determined in accordance with BS EN 13040. Quantity can be determined in accordance with BS EN 12580, the scope of which covers compost consisting of no more than 10 % volume/volume of particles greater than 60 mm in size.*

- d) information that enables traceability checks (e.g. unique compost batch code, or similar for any product containing compost);

*NOTE Examples of other information that enables traceability checks are date of bagging and dispatch records.*

- e) instructions for storage (e.g. store in a cool, dry place);
- f) if supplied for use in agriculture or soil-/field-grown horticulture, test results or typical values for each parameter applicable to the compost grade (see Clause 14);

*NOTE Results can be those of tests on the batches supplied to fulfil the particular order or those typical of other batches of the same compost grade, the latter calculated from sufficient test results of graded batches produced according to the validated QMS). Recipients of compost for use in these and other markets should also be informed about characteristics that affect its appropriate storage and use (see Clause 14 and Annex C).*

- g) warning about product misuse, risks when handling and safety advice or symbols as appropriate;
- h) statement of conformity with this PAS as follows, appropriate to the compost or product containing it <sup>7)</sup>;

'Conforms to PAS 100', or

'Contains compost conforming to PAS 100';

*NOTE Where the second statement is used, declaration of the approximate percentage of conforming compost in the product is recommended, either on a volume/volume or mass/mass basis.*

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7) Marking PAS 100 on or in relation to a compost represents a composter's declaration of conformity, i.e. a claim by or on behalf of the composter that the compost meets the requirements of this PAS. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is different from certification of conformity by an organization independent of the composter, which is recommended.

- i) input material types from which the compost is made, and if any of them are ABPs;
  - 1) a statement that the compost is made from ABPs;
  - 2) instructions on restrictions on use; and
  - 3) instructions on records the user is required to make and keep, according to ABP Regulations;

*NOTE The composter should check the relevant Animal By-Products Regulations [21 as amended by 22], [23], [24], [25] or [26] for all requirements relating to the supply and use of composts derived from ABPs. It is important that the compost recipient is made aware of the obligations upon him/her and that non-compliance is an offence. PAS 100 Clause 17 i) also applies to any compost derived from catering wastes.*

- j) contact details of the composter or the organization supplying the compost on the composter's behalf.

## **17 Traceability**

**17.1** The composter shall carry out operations such that input materials, composting batches and compost batches (whether screened or not) are identified and traceable, from arrival on site for composting to dispatch from the site, whether PAS 100 conforming or not.

*NOTE Guidance on achieving traceability is provided in Annex D.*

**17.2** The following shall also be traceable:

- a) product containing PAS 100 conforming compost;
- b) compost bagged off-site by or on behalf of the composter;
- c) product containing PAS 100 conforming compost bagged off-site by or on behalf of the composter;
- d) oversize material;
- e) any compost batch that is reprocessed;
- f) any composting batch or part-batch that has been partially processed then sent for disposal or any other suitable regulated use; and
- g) any composting batches that are combined after successful completion of their respective sanitization steps.

**17.3** During any period when compost or product that contains it is stored in a continuous pile, batches shall be deposited such that:

- a) they remain identifiable; and
- b) when dispatched, information supplied about each consignment includes reference to the relevant batch(es).

**17.4** The composter shall make and keep records that enable traceability checks.

**Annex A (informative)**  
**Recommendations for the sanitization step**

The sanitization step in a composting process serves as the CCP for minimization of risks associated with human, animal and plant pathogens [see 5.1.1 a) and b)]. Table B.1 provides recommendations for the parameters and CLs that should be set, monitored and recorded. **It is the responsibility of the composter to set CLs for each sanitization parameter, as appropriate to characteristics and proportions of input material types, how the composting process is managed (including the composting conditions), and intended uses of the compost grade(s).**

Processes that make compost wholly or partially from plant tissue biowaste/material should be assessed in terms of the risks to plant health. Risk assessment should take account of plant pests and pathogens that could be present in the input materials.

Guidance is provided in the Food and Environment Research Agency’s ‘Code of practice for the management of agricultural and horticultural waste’ [k], and the European and Mediterranean Plant Protection Organization’s (EPPO) ‘Guidelines for the management of plant health risks of biowaste of plant origin’ [l]. (Their recommendations might change following publication of the current review of management of plant health risks associated with processing of plant-based wastes, project PH0402 supported by the Department for Environment, Food and Rural Affairs, one of the outputs from which is the paper referenced [r] in the Bibliography).

The EPPO guidance recommends that where biowaste/material of plant origin is known or suspected to contain any “notifiable” (also referred to as “quarantine”) plant pests or pathogens the sanitization step and whole composting process should be authorized and supervised by the National Plant Protection Organization (see reference [k] document for organization names and contact details). Information about “notifiable” plant pests and pathogens can be downloaded from <http://www.fera.defra.gov.uk/plants/publications/plantPestDiseaseFactsheets.cfm>. The named plant pathogen and pest species should not be regarded as comprehensive.

<b>Table A.1 – Recommended parameters and minimum crucial limit values for eradication of most pathogens during sanitization <sup>a)</sup></b>			
<b>Temperature</b>	<b>Time <sup>b)</sup></b>	<b>Moisture</b>	<b>Mixing/turning</b>
65 °C	7 days	51 % mass / mass	Applicable if necessary in order to expose the whole batch to the recommended minimum conditions <sup>c)</sup> . Number of mixes/turns as applicable to the composting system (incl. machinery)

<sup>a)</sup> Applicable to all composting systems, for all of the human- and animal-pathogens and most of the 60 plant-pathogens and nematode species reviewed [s] and subjected to bench- and commercial-scale trials [see reference [t], p 20, recommendation i)]. The plant pathogens the Table B.1 regime should eradicate include “club root” of brassicas (*Plasmodiophora brassicae*), *Fusarium oxysporum* f.sp *Lycopersici* and *Fusarium oxysporum* f.sp *Radicis-lycopersici*. Conditions found effective for eradication of *Plasmodiophora brassicae* were 65 °C with 51 % m/m moisture for 1 day, and under other test conditions 60 °C with 59 % m/m moisture for 1 day [see reference [t], p 20, recommendation h)].

<sup>b)</sup> The recommended minimum temperature and moisture should be maintained continuously over a period of 7 days. However, it is recognized that continuous monitoring and recording of temperature and moisture for 7 consecutive days will not be achieved where the composting process does not have a monitoring system that continuously records such data. It is also recognized that where monitoring

procedures are carried out manually by staff who use equipment that takes discrete readings, monitoring is not carried out on any days when such staff do not work on-site (e.g. Sundays). Under those circumstances, proof that minimum temperature and moisture has been maintained continuously over a period of 7 days would not be possible. Thus, the composters should ensure that the CLs set for the sanitization step are clear and appropriate given the nature of the composting and monitoring systems.

<sup>c)</sup> In systems where the composting batch remains static, insulation or auxiliary heat might expose the entire composting batch to sanitizing conditions without mixing/turning. In systems that utilize batch mixing/turning, each mix or turn should be carried out after the batch has been exposed to Table B.1's recommended minimum temperature and moisture conditions over a period of 7 days. However, it is recognized that some composting systems might rely on more frequent batch mixing/turning in order to move composting material through the sanitization step.

For systems composting ABPs inputs, the regime in Table B.1 can be integrated with, or enhance, the sanitization regime for human and animal pathogens in the approval from the competent authority.

To maximize sanitization performance, thermophilic temperatures should be maintained between 45 °C and 80 °C, and moisture should be maintained at least at 40 % mass/mass throughout the subsequent stabilization step.

*NOTE* Contact the Association for Organics Recycling for further guidance <sup>8)</sup>.

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<sup>8)</sup> Association for Organics Recycling, 3 Burystead Place, Wellingborough, Northamptonshire, NN8 1AH. Tel: +44 (0) 1933 446440, [www.organics-recycling.org.uk](http://www.organics-recycling.org.uk).

## **Annex B (informative)**

### **Recommended tests and declarations according to compost use**

Specifiers, advisers and manufacturers of products that consist of or contain compost will want to know the compost's characteristics, as will users. The information supplied should be appropriate to their technical knowledge and requirements. Table C.1 below recommends declaration of test results relevant for the main compost product types and other products in which compost could be used as an ingredient. The composteer should also declare results of those obligatory tests specified in Clause 14, Table 3 relevant to the technical knowledge and requirements of the customer.

Examples of how information about compost characteristics may be supplied are:

- a) copies of laboratory test reports;
- b) the composteer's technical product specification; and
- c) on printed bags.

The composteer's technical product specification usually states the typical value for each parameter, calculated from test results of compost samples. Some potential customers might also want to know the range for each parameter or the test results for the particular compost batch(es) supplied.

The Waste & Resources Action Programme has supported the development and publication of '*Guidelines for the specification of quality compost for use in growing media*' [m] and '*Compost specifications for the landscape industry*' [o]. For more information about standards and specifications that build on PAS 100, see the bibliography's section "References to documents that are not legislation".

A range of benefits associated with compost use have also been reviewed and reported in WRAP's publication '*To support the development of standards for compost by investigating the benefits and efficacy of compost use in different applications*' [u].

**It is recommended that the soil to which the compost is applied is tested prior to compost application. This is important to establish the existing soil conditions and calculate the crop requirement and the correct compost application rate.**

**Table B.1 – Recommended tests and declarations for compost parameters according to compost use**

Parameter	Method of test	Compost use				
		Mulch <sup>a)</sup>	Soil improver <sup>b)</sup>	Manufactured topsoil (ingredient) <sup>b), c)</sup>	Turf dressing <sup>b), d)</sup>	Growing medium (ingredient) <sup>b), d)</sup>
Particle size distribution <sup>e)</sup>	AfOR MT PC&S	✓ EO	✓ EO	✓ EO	✓ EO	✓ EO
Moisture or dry matter	BS EN 13040	✓ EO & EOQP	✓ EO & EOQP	✓ EO	✓ EO	✓ EO
Loss on ignition (organic matter)	BS EN 13039	—	✓ EO & EOQP	✓ EO	✓ EO	✓ EO
Total organic carbon	Calculated by dividing loss on ignition result by 1.72	✓ EOQP	✓ EOQP	✓	—	✓
C:N (carbon to nitrogen ratio)	Calculated by dividing total organic carbon by total nitrogen	—	—	✓	—	✓
Electrical conductivity	BS EN 13038	—	✓ EO	✓ EO	✓ EO	✓ EO
pH <sup>f)</sup>	BS EN 13037	✓ EOQP	✓ EOQP	✓	✓	✓
'Total' nitrogen [N]	BS EN 13654-1 (Kjeldahl) or BS EN 13654-2 (Dumas), as appropriate	✓ EOQP	✓ A, FGH <sup>h)</sup> , EOQP	✓	✓	✓
'Total other' nutrients and sodium salts: <sup>g)</sup>						
Primary; phosphorus [P], potassium [K]	BS EN 13650	✓ EOQP	✓ A, FGH <sup>h)</sup> , EOQP	✓	✓	✓

Secondary; calcium [Ca], magnesium [Mg], sulphur [S]		✓ EOQP	✓ A, FGH <sup>h)</sup> , EOQP	✓	✓	✓
Trace; boron [B], copper [Cu], iron [Fe], manganese [Mn], zinc [Zn]		—	✓ A, FGH <sup>h)</sup>	✓	✓	✓
Sodium [Na]		—	—	✓	✓	✓
Calcium chloride and DTPA (“CAT”) soluble nutrients and sodium salts: <sup>1)</sup>						
Primary; phosphorus [P], potassium [K]	BS EN 13651	—	—	✓	✓	✓
Secondary: magnesium [Mg], sulphur [S]		—	—	✓	✓	✓
Trace: boron [B], copper [Cu], iron [Fe], manganese [Mn], zinc [Zn]		—	—	✓	✓	✓
Sodium [Na]		—	—	✓	✓	✓
Water soluble nutrients and sodium salts: <sup>1)</sup>						
Primary; ammoniacal-N, nitrate-N, phosphorus [P], potassium [K]	BS EN 13652	—	✓ A, FGH <sup>h)</sup>	✓	✓	✓
Secondary; calcium [Ca], magnesium [Mg], sulphur [S]		—	✓ A, FGH <sup>h)</sup>	✓	✓	✓
Trace: boron [B], chloride [Cl], copper [Cu], iron [Fe], manganese [Mn], zinc [Zn]		—	✓ A, FGH <sup>h)</sup>	✓	✓	✓
Sodium [Na]		—	—	✓	✓	✓
Neutralising value (liming potential, expressed as % mass / mass CaO)	See note k)	—	✓ A, FGH	—	—	—

### Key

✓ = test/determination and declaration strongly recommended (in product’s technical specification, other labelling, or by supplying a copy of the laboratory test report)

EO = test effectively obligatory as results used in other PAS 100 obligatory tests  
EOQP = test effectively obligatory as “QP Manager” webtool (www.qualityprotocols.com) for using quality composts in agriculture and field-grown horticulture markets uses this result to generate the compost benefit statement. Requirements that control the use of compost in agriculture and field-grown horticulture are set in the Compost QP [a]  
A = agriculture  
FGH = field grown horticulture

### Units as per user/market requirements

Expression of results on a dry matter basis: mg/kg, with optional conversion to % mass/mass.

Expression of results on a fresh matter basis (as received): mg/l or mg/kg as appropriate to parameter, with optional conversion to % mass/mass.

When planning compost use in agriculture and field-grown horticulture, results should be converted to compost loading rates and declared. For example, total phosphorus result should be converted to kg P<sub>2</sub>O<sub>5</sub> per tonne of fresh compost and total potassium result converted to kg K<sub>2</sub>O per tonne of fresh compost. Respectively, these are phosphate and potash loading rates.

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<sup>a)</sup> *Products consisting entirely of coarse woody particles, for example, those > 10 mm. Compost graded such that it contains a high proportion of fine particles should be described as a “soil improver”.*

<sup>b)</sup> *Reference should be made to sanitization performance and results of any plant pathogen tests.*

<sup>c)</sup> *The concentrations of major, secondary and trace elements are defined in the Fertilisers Regulations 1991 [35] (as amended).*

<sup>d)</sup> *Compost is very likely to be an ingredient rather than the sole constituent.*

<sup>e)</sup> *Results provide more detailed information and evidence supporting the ‘nominal particle size grade’ that is required to be declared in labelling [see Clause 17 item b)]. Determination of particle size distribution is an integral part of the method of test instructed in AfOR MT PC&S (see Clause 2), which is specified in Table 3 for determination of physical contaminants and stones in compost.*

<sup>f)</sup> *Advise the user about restrictions on use with ericaceous plants (those that require relatively acidic soils in which to grow). Element bioavailability and leaching is affected by pH, so the pH result is likely to be taken into account when forecasting effects of compost PTEs and nutrient content on soils, plants, the wider environment and human health. Regarding the use of compost in agriculture, some trials have monitored the effects of composts on the pH of the soils to which they were applied. Soils differ in terms of how readily their pH can change, and one trial involving compost applications over 4 years found no clear effect on soil pH (Organic Resource Agency’s report [v]). When the average percentage change soil pH over the 4 years of the trial was evaluated, there did not appear to be a more marked effect from the highest compost application rate. Other 5 year trials [w] have shown that compared using only fertilizer, repeated compost applications marginally raised soil pH. Artificial fertilizers tend to exert acidifying effects on soils.*

<sup>g)</sup> *This method uses hydrochloric- and nitric-acid (“aqua-regia”) extractants and approximates “total” rather than “bioavailable” element concentrations in the compost. Molybdenum [Mo] is also required by plants in trace amounts but has not been included in the routine test suite (primary, secondary and trace nutrients) due to the extra cost of additional equipment for determining its concentration at low detection level. The same applies to methods for and costs of determining Mo concentrations in water- and CAT-extractable forms. A price quote should be requested from the laboratory if necessary. Chloride is a further trace element required by plants but is not covered in BS EN 13650 because the*

chloride in the hydrochloric acid would affect the test result. Sodium is included in the routine test suite because high concentrations of sodium chloride [NaCl] inhibit plant growth.

<sup>h)</sup> If intended for application to soil under an Environmental Permit, waste management licence or exemption, the regulator:

- will require reporting of % dry matter, pH and “total” and “soluble” forms of nitrogen [N], phosphorus [P], potassium [K], calcium [Ca], magnesium [Mg], and sulphur [S] in compost; and
- might require reporting of additional parameters, which could include those that indicate potential immobilization of available nitrogen, the PTEs listed above and additional PTEs such as molybdenum [Mo], selenium [Se], arsenic [As], and fluorine [F].

When planning the use of compost in restoration of contaminated land, additional PTEs and substances in compost might need to be tested and evaluated if any Soil Guideline Values are at risk of being exceeded. Method of test BS EN 13650 does not cover the PTEs selenium, arsenic and fluorine.

<sup>i)</sup> This method uses the extractants calcium chloride and diethylenetriaminepentaacetic acid (commonly abbreviated as “CAT”). They are less aggressive extractants than “aqua regia” (BS EN 13650) but more aggressive than water (BS EN 13652). CAT extractants are intended to mimic nutrient/PTE uptake processes used by plant roots and, compared with water as an extractant, tend to extract higher concentrations of most elements into solution. Element concentrations derived using CAT extractants are believed to reflect longer term bioavailability of certain essential plant nutrients (such as phosphorus and iron) and potentially toxic elements present (such as zinc) more accurately because molecules containing these elements have low solubility in water. Regarding Mo, see footnote k. Plant nutrients calcium [Ca] and chloride [Cl] are not covered by this method because these elements are in the extractants and would affect Ca and Cl test results. Sodium is included in the routine test suite because high concentrations of sodium chloride [NaCl] inhibit plant growth.

<sup>j)</sup> Test results from this method indicate the likely amount of each element that is immediately available for uptake by plants. Regarding Mo, see footnote k. Determination of fluorine concentration is also covered by this method but is omitted from the routine test suite because this test would entail extra cost and its water soluble concentration might not be a good indicator of FI-toxicity. Sodium is included in the routine test suite because high concentrations of sodium chloride [NaCl] inhibit plant growth.

<sup>k)</sup> Test procedure as per The Fertilisers (Sampling and Analysis) Regulations 1996, Schedule 2, Part II Section 6 - Determination of the neutralizing value of liming materials [37]. Method adaptation: the stage of passing the sample through a 1 mm sieve is omitted and results are expressed as % by weight of CaO on the undried sample, as received.

**Annex C (informative)**  
**Traceability guidance**

This annex provides guidance on key activities and associated records for identifying and tracing materials, from arrival at the composting site to dispatch from the site, whether PAS 100 conforming or not (in accordance with the requirements in Clause 18).

<b>Table C.1 – Traceability guidance</b>		
<b>Activity</b>	<b>Record type</b>	<b>Traceability information</b>
Input material deliveries accepted for composting	Weighbridge tickets and/or other documentation for deliveries accepted	Ticket date and number, material type(s), source(s), haulier and client
Rejected contaminants and/or any materials unsuitable for feeding into the composting process	Weighbridge tickets and/or other documentation for contaminants/materials rejected	Ticket date and number, material type(s), source(s), haulier and client
Composting batch formation	Batch processing	Start and finish dates of batch formation <sup>a)</sup> , composting batch code <sup>b)</sup>
Composting batches combined after sanitization (if applicable)	Batch processing	Codes of relevant batches, date combined and revised code carried forward
Composting batch corrective action or reprocessing (if applicable)	Batch processing	Date corrective action/re-processing started and if reprocessed, old and new composting batch codes <sup>c)</sup>
Product preparation (e.g. screening, blending or bagging <sup>d)</sup> as applicable)	Batch processing	Date, resulting particle size grade(s) if screened, composting- and product-batch code(s), product type (if particle size grade insufficient to distinguish between products)
If screening is applicable, oversize material	Batch processing	Date of screening, code of screened batch(es), storage location of resulting oversize material. If fed back into composting process, start and finish dates of batch formation and composting batch code. If pre-treated before re-composting, date, brief description of pre-treatment and relevant oversize batch codes treated. Alternatively if dispatched from site, see last row in this table
Product storage	Site/storage area plan	Storage location of each batch
Compost/product/material	Weighbridge ticket	Date, compost batch code(s),

dispatched from site	and/or other dispatch documentation	product type (if particle size grade insufficient to distinguish between products), or if non-conforming material, the compost batch code(s), destination and to whom sent
<p><sup>a)</sup> <i>The actively managed composting period starts on the working day after the date when formation of the composting batch is finished.</i></p> <p><sup>b)</sup> <i>The composting batch retains the same code through sanitization and stabilization but note the provision for any batches that are combined after sanitization. If a maturation step is used before or after product preparation, traceability information relevant to the compost grade(s) also needs to be recorded.</i></p> <p><sup>c)</sup> <i>Batches undergoing re-processing may be split, additional input material incorporated and thus undergo composting from the start of the sanitization step as one or more new composting batches.</i></p> <p><sup>d)</sup> <i>Bagging is applicable if carried out on- or off-site, by or on behalf of the composter.</i></p>		

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