PAS 110:2014

Specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials

wrap

Working together for
a world without waste

bsi.

Publishing and copyright information

Published by BSI Standards Limited 2014.

ISBN 978 0 580 82661 0

ICS 13.030.99

Images provided courtesy of Agrivert Ltd, GWE Biogas Ltd, Fernbrook Bio Ltd & Barfoot Energy Ltd.

Publication history

First published February 2010
Second edition July 2014

Contents

Foreword

This PAS was sponsored by WRAP (Waste & Resources Action Programme). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 31 July 2014.

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

- Anaerobic Digestion Operators Working Group (ADOWG);
- Anaerobic Digestion & Biogas Association (ADBA);
- Andigestion Ltd
- Biofertiliser Certification Scheme (BCS);
- Chartered Institution of Wastes Management (CIWM);
- Earthcare Technical Ltd;
- Environment Agency;
- Environmental Services Association (ESA);
- Natural Resources Wales;
- NRM Laboratories (a division of Cawood Scientific Ltd);
- Red Tractor Assurance;
- Renewable Energy Association (REA);
- Scottish Environment Protection Agency (SEPA);
- SFQC;
- Welsh Government;
- WRc plc; and
- WRAP.

Acknowledgement is also given to the members of a wider review panel who were consulted in the development of this PAS.

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 It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a specification to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Supersession

This PAS supercedes PAS 110:2010, which is withdrawn.

Marking "PAS 110:2014" on or in relation to whole digestate, separated liquor or separated fibre represents a producer's declaration of conformity, i.e. a claim by, or on behalf of, the producer 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.

Producers who use this PAS are advised to apply for, and obtain, third-party certification of product conformity with this PAS.

Producers and users seeking the relevant certification body, or bodies, may ask BSI to forward their enquiries to the relevant organizations.

Use of this document

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this PAS are presented in roman (i.e. upright) 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 italic type, and does not constitute a normative element (requirement). Much of this appears as Notes in this PAS, each beginning with "NOTE".

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a PAS cannot confer immunity from legal obligations.

In addition to the requirements of this PAS, attention is drawn to the following statutory requirements, the *Codes of Good Agricultural Practice* and the Anaerobic Digestate Quality Protocol (ADQP), some of which are also referred to in the Introduction:

- Environmental Protection Act 1990 (as amended) [1];
- The Waste (England and Wales) Regulations 2011 [2];
- Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 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) [3];
- Commission Regulation (EU) No 142/2011 of 25 February 2011 implementing Regulation (EC) No 1069/2009 of the European Parliament and of the Council laying down health rules as regards animal by-products and derived products not intended for human consumption and implementing Council Directive 97/78/EC as regards certain samples and items exempt from veterinary checks at the border under that Directive, and subsidiary UK legislation [4];
- *Protecting our Water, Soil and Air – A Code of Good Agricultural Practice for farmers, growers and land managers*, Department for the Environment (England), 2009 [5];
- *The Code of Good Agricultural Practice For the Protection of Water, Soil and Air for Wales*, Welsh Assembly Government (2011 No.20) [6];
- *Prevention of Environmental Pollution from Agricultural Activity, A Code of Good Practice* (PEPFAA Code), Scottish Executive (only applicable in Scotland) [7];
- The Environmental Permitting (England and Wales) Regulations 2010 (and as amended) [8];
- The Pollution Prevention and Control (Scotland) Regulations 2012 [9];
- The Waste Management Licensing (Scotland) Regulations 2011 [10];
- The Waste Management Licensing Regulations (Northern Ireland) 2003 [11];
- The Pollution Prevention and Control Regulations (Northern Ireland) 2003 [12];
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives [13];
- *Quality Protocol. Anaerobic digestate. End of waste criteria for the production and use of quality outputs from anaerobic digestion of source-segregated biodegradable waste*, (Environment Agency) [14];
- General requirements (food hygiene). Codex Alimentarius *Principles of the HACCP System*, FAO, 2003 [15].

0 Introduction

0.1 What is anaerobic digestion?

Well-managed anaerobic digestion (AD) systems are capable of conferring multiple environmental and socio-economic benefits. This type of biological treatment technology has become well established in some countries of the European Union but is currently under-utilized in the UK. AD is an important technology for the local recovery of source-segregated biowastes, especially those that arise as liquids and the more putrescible fractions of solid biowastes. The biogas they produce can be converted into energy for the use of the AD system itself, for local use, for supply as electricity to the national grid or for processing into biofuel for vehicles.

The whole digestate, separated liquor and separated fibre outputs that AD systems can produce have significant fertilizer value and can return useful amounts of organic matter to soils. Such digested materials are particularly suitable for maintaining and improving soil fertility and function. Benefits of these kinds can effect particular value in agriculture, soil-grown horticulture (field and some covered crops grown in soil), forestry, land restoration, land reclamation and land remediation applications.

__NOTE__ See Clause __3__ for definitions of the terms "whole digestate", "separated liquor" and "separated fibre".

The whole process of AD and the controlled application of digestates reduces the environmental impact of manures and biowaste streams by lowering methane emissions and controlling odours. Such applications have the potential to reduce nitrogen losses to groundwater, surface water and the atmosphere.

The volume of digestates is increasing significantly as industry responds to the latest strategies in the nations of the UK for diverting biowastes from landfill [2], and to other policy initiatives and measures geared to developing the supply of renewable energy, tackling climate change and protecting soils.

0.2 What is PAS 110?

The purpose of this PAS is to remove a major barrier to the development of AD, namely, by encouraging markets for digestates. It is an industry specification against which producers can check that the digestates are of consistent quality and fit for purpose. This PAS, together with other supply and demand market development measures, should encourage more sustainable practices in the management of biowastes and biodegradable materials.

This PAS is a fast-track precursor to a potential future British Standard. This voluntary, industry-led specification sets out the minimum quality required for whole digestate, separated liquor and separated fibre that might be used as fertilizer or soil improver/conditioner. Meeting its quality and other criteria enables the producer to demonstrate compliance with this PAS.

0.3 Obligations under relevant regulations

This PAS is a non-statutory document and does not set regulatory limit values for the quality and use of digestates (whole digestate, separated liquor and separated fibre). All producers are required to comply with all applicable legislation, irrespective of whether or not the whole digestate, and any separated liquor and fibre, conforms to this PAS.

Whilst compliance with this PAS helps producers to demonstrate due diligence in the recovery of controlled, source-segregated biowastes, it does not exempt the digestion facility or its digestates from environmental or health protection regulations (see references in the Foreword). The production and use of digestates derived from controlled biowastes is subject to environmental permitting or waste management licensing regulations, according to the country in which the AD process is located and the digestate is used.

In England and Wales, processes that digest controlled, source-segregated biowastes must have an authorization to operate, or an exemption. An example of an authorization is an environmental permit [8] (permits include waste management licences

and exemptions issued prior to 6 April 2008 when the environmental permitting regulations came into effect). In Scotland, processes that treat biowastes must have a Waste Management Licence (WML) or an exemption from licensing.

In some circumstances, pollution prevention and control regulations ([9] and [12]) also apply; facilities treating more than a threshold amount of Category 3 animal by-products are to have a Pollution Prevention and Control Permit (PPC).

The use of digestates made from controlled, source-segregated biowastes is subject to environmental permitting (in England and Wales) [8] or waste management licensing regulations (in Scotland) [10]. However, in countries that have adopted the Anaerobic Digestate Quality Protocol (ADQP) [14], there might be a case for digestates to be exempted from the environmental permitting/waste management regulations that control their use, if the ADQP requirements are met. Those requirements include independent certification of conformance to this PAS. In such circumstances, restrictions on digestate end-use markets apply.

Enquiries about ADQP applicability in a specific country should be addressed to its agency responsible for protecting the environment. Whatever the circumstances, land managers should follow the relevant parts of the *Codes of Good Agricultural Practice* for the protection of air, water and soils [5 if in England, 6, if in Wales, or 7, if in Scotland], or any superseding publications.

0.4 How does PAS 110 work?

PAS 110's Clause **1** states which digested materials are within or outside its scope. This PAS's requirements begin at Clause **4** on the topic of quality management systems and continue in Clause **5** on the topic of hazard analysis and critical control point (HACCP) planning. The subsequent clauses follow a digestate production sequence, beginning with requirements for the input materials, progressing to process management controls and monitoring, and then to digestate sampling, testing, validation checks and information for end users. Such information enables appropriate use of digestates, minimizing the risks of environment pollution or adverse effects on humans, animals or plants.

This page deliberately left blank

1 Scope

This PAS covers whole digestate from an anaerobic digestion (AD) system that accepts only source-segregated biowastes (see **3.68** and **3.8**) and/or biodegradable non-waste materials (see **3.7**). It also covers liquor and fibre fractions that might be produced by separating whole digestate, after the AD process.

NOTE 1 *Digestates that conform to this PAS should be suitable for use as soil improvers/conditioners, without causing harm or nuisance. They should confer beneficial effects when used, as a result of their combined physical, chemical and microbial properties (see Clause **12**). Clause **12.1.1 d)** requires that the digestate placed on the market is fit for purpose.*

NOTE 2 *The addition of further biowaste/biodegradable material to separated fibre at the start of, or during, maturation is outside the scope of this PAS. In this scenario, the PAS 100, Specification for composted materials derived from source-segregated biodegradable materials might be applicable. If digestate, composted material or a blended mixture of treated, source-segregated biowastes, soil or soil-like material is placed on the market for use as a "product", it will have to meet all requirements of the relevant Quality Protocol in any country in which it applies.*

This PAS specifies:

a) controls on input materials and the management system for the process of AD and associated technologies;

b) that the AD system is allowed to accept packaged biowastes/biodegradable non-waste materials that are depackaged prior to AD, subject to **6.1**;

c) the minimum quality of whole digestate (see **3.83**), separated liquor (see **3.65**) and separated fibre (see **3.64**);

d) information that is required to be supplied to digestate (see **3.21**) customers (see Clause **14**).

This PAS includes a reduced range of test parameters for digestates made from specific input materials that arise within a single [or co-operative's (see **3.16**)] premises or holding and that are returned for use entirely within the same premises or holding (see **11.2.4**). The producers using such materials are exempt from carrying out a pasteurization step during AD (see **7.2** and **3.53**). These provisions have been extended in this edition to include farming/horticultural/forestry co-operatives (as defined in **3.16**).

Exemption from the pasteurization step has also been allowed for specific input materials that arise within a single (or co-operative's) premises or holding, which are co-digested with pasteurized biodegradable materials/wastes from outside the producer's premises or holding, provided that the digestate is returned to, and used entirely within, the originating single or co-operative's premises or holding in a way consistent with the relevant premises' or holding's animal health plan (see **7.2.5**).

NOTE 3 *See **11.2.4** regarding whether the digestate can be tested according to a reduced range of parameters.*

NOTE 4 *Check the regulator's relevant position statement or briefing note regarding the circumstances in which waste regulatory controls do not apply to agricultural manures and slurries, and crops grown specifically for AD.*

This PAS requires the producer to undertake hazard analysis and critical control point (HACCP) planning (see **3.36** and Clause **5**) and to implement and maintain a quality management system (QMS) (see **3.59** and Clause **4**) that ensures digestates meet the minimum quality requirements set out in this PAS, and are fit for purpose.

2 Normative references

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

Standards publications

BS EN 13037, *Soil improvers and growing media – Determination of pH*

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

BS EN 13654-1, *Soil improvers and growing media – Determination of nitrogen – Part 1: Modified Kjeldahl method*

BS EN 13654-2, *Soil improvers and growing media – Determination of nitrogen – Part 2: Dumas method*

BS EN 14346, *Characterization of waste – Calculation of dry matter by determination of dry residue or water content*

BS EN 15169, *Characterization of waste – Determination of loss on ignition in waste, sludge and sediments*

BS EN ISO 15587-1:2002, *Water quality – Part 1: Digestion for the determination of selected elements in water – Aqua regia digestion*

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

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

Other publications

[N1] ENVIRONMENT AGENCY, Standing Committee of Analysts. SCA MSS Part 3A. The Microbiology of Sewage Sludge (2003) – Part 3 – Methods for the isolation and enumeration of *Escherichia coli*, including verocytotoxigenic *Escherichia coli*, *Methods for the Examination of Waters and Associated Materials* (A – The isolation and enumeration of *Escherichia coli* by a chromogenic membrane filtration technique). Blue Book No. 190. Environment Agency, 2003. Downloadable from http://www.environment-agency.gov.uk/static/documents/Research/mss2003__part_3_604573.pdf.

[N2] ENVIRONMENT AGENCY, Standing Committee of Analysts. SCA MSS Part 4A. The Microbiology of Sewage Sludge (2004) – Part 4 – Methods for the detection, isolation and enumeration of *Salmonellae*, *Methods for the Examination of Waters and Associated Materials* (A – The detection of *Salmonella spp.* by use of a presence/absence technique). Blue Book No. 195. Environment Agency, 2004. Downloadable from http://www.environment-agency.gov.uk/static/documents/Research/mss2004__part_4_811642.pdf.

[N3] NRM LABORATORIES. NRM method JAS-497/001. *Determination of Physical Contaminants and Stones in Digestate.* NRM Laboratories, 2012. (Previously described as: REA-DM-PC&S. *Methodology for determination of physical contaminants and stones in digestates*. London: Renewable Energy Association.

[N4] EUROFINS LABORATORIES LTD. SOP Z/004. The determination of ammonium in organic wastes (liquid or solid), Standard Operating Procedure Z/004. Edition 05. Wolverhampton: Eurofins Laboratories Ltd, 2006. [1)]

NOTE *This method of test is based on Method 53 in RB 427, The Analysis of Agricultural Materials, Ministry of Agriculture, Fisheries and Food, 1986 (London: HMSO).*

[N5] NRM LABORATORIES. NRM Method JAS-083. The determination of ammonium in organic wastes (liquid or solid), NRM Laboratories. [2)]

[1)] Broadoak Business Park, Ashburton Rd, Manchester M17 1RW.
[2)] NRM Ltd, Coopers Bridge, Braziers Lane, Bracknell, Berkshire RG42 6NS.

[N6] WASTE & RESOURCES ACTION PROGRAMME (WRAP). OFW004-005. *Residual biogas potential test for digestates, Development and evaluation of a method for testing the residual biogas potential of digestates* (Section 4, Full description of the RBP Test). Waste & Resources Action Programme, 2010.

NOTE *Total solids (abbreviated as "TS", also referred to as "dry matter") and volatile solids (abbreviated as "VS", also referred to as "loss on ignition", which is a measure of organic matter) should be determined as instructed in the report (see* ***4.2*** *of the report). Volatile fatty acids should be determined by gas chromatography; an example specific to the equipment used during development of the residual biogas potential (RBP) test is provided in OFW004-005's Appendix 9.2, which is downloadable from http://www.wrap.org.uk/sites/files/wrap/Residual%20Biogas%20Potential.pdf*

3 Terms and definitions

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

3.1 agriculture

horticulture (soil-/field-grown), fruit growing, seed growing, livestock farming, the use of land as grazing land, meadowland, osier land, 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

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 biogas and whole digestate

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

3.3 animal by-product (ABP)

entire bodies or parts of animals or products of animal origin referred to in Articles 2 and 3 of EU Regulation No 1069/2009 [3] that are not intended for human consumption, including ova, embryos and semen

NOTE *Articles 8, 9 and 10 of EU Regulation No 1069/2009 [3] respectively state Category 1, Category 2 and Category 3 ABPs. "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* ***3.9****) and "former foodstuffs" are Category 3 ABPs, which can be recovered using a digestion process.*

3.4 Animal Health

governmental executive agency primarily responsible for ensuring that farmed animals in Great Britain are healthy, disease-free and well looked after

3.5 authorization

3.5.1 authorization

<AD activity in England and Wales> environmental permit issued under the Environmental Permitting (England and Wales) Regulations 2010 [8]

3.5.2 authorization

<AD activity in Scotland> licence issued under the Environmental Protection Act 1990, (as amended) [1] and the Waste Management Licensing (Scotland) Regulations 2011 [10], or a Pollution Prevention and Control (PPC) Permit issued under the Pollution Prevention and Control (Scotland) Regulations 2012 [9]

3.5.3 authorization

<AD activity in Northern Ireland> licence issued under the Waste Management Licensing Regulations (Northern Ireland) 2003 [11] or a Pollution Prevention and Control (PPC) Permit issued under the Pollution Prevention and Control Regulations (Northern Ireland) 2003 [12]

3.6 batch or portion of production

unit of whole digestate, separated fibre or separated liquor produced by a single AD production process, using uniform critical control points and critical limits, or a number of such units, when stored together, and that can be identified for the purposes of retreatment or disposal, should monitoring checks or sample tests necessitate such actions

NOTE *Batch or portion of production size is defined by the producer, rather than in this PAS, due to differences between AD system types.*

3.7 biodegradable

capable of undergoing biologically mediated decomposition

3.8 biowaste

waste of animal or plant origin that can be decomposed by microorganisms, other, larger soil-borne organisms or enzymes

[For the purposes of this PAS, biowaste must be source-segregated (see **3.68**)]

NOTE *See Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives [13] for further definitions.*

3.9 catering waste

3.9.1 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 No 1069/2009 [3] also designates non-meat food fractions as catering wastes, most of which are Category 3 ABPs.*

3.9.2 catering waste

<excluding meat> separately collected catering waste types where measures have been taken with the aim of excluding any meat

3.10 certification

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

NOTE 1 *In the context of PAS 110, assessment by a certification body covers all the requirements of PAS 110.*

NOTE 2 *In the context of the Anaerobic Digestate Quality Protocol (End of waste criteria for the production and use of quality outputs from anaerobic digestion of source-segregated biodegradable waste (ADQP)) [14], assessment by the approved certification body covers all the requirements of that protocol, including all those in the producer's chosen, approved standard/specification (e.g. PAS 110).*

3.11 certification body

independent 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 digestates to PAS 110.*

3.12 chemical oxygen demand (COD)

indirect measure of the amount of organic compounds in a substance, in which a sample of the substance is incubated with a strong chemical oxidant under specific temperature conditions and for a particular period of time

NOTE *In this context, a COD test determines the amount of oxygen consumed per amount of digestate (sample), and is normally expressed in mg/l or parts per million (ppm) in older references. The chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, so both of these sources of oxygen demand are measured in a COD test.*

3.13 competent authority

central authority of a Member State competent to ensure compliance with the requirements of the EU Animal by-products Regulation No 1069/2009 [3], 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.*

3.14 control

3.14.1 control

<noun> [3)] state wherein correct procedures are being followed and criteria are being met

3.14.2 control

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

[3)] Definitions 3.14 to 3.15 and 3.17 to 3.19 are from Codex, *Basic Texts On Food Hygiene Codex Alimentarius*, Rome: FAO, 2001 (second edition) [15]. Minor changes have been made to some to make them more appropriate within the context of AD. See http://www.fao.org/docrep/005/Y1579E/Y1579E00.HTM for more information.

3.15 control measure

action and activity that can be used to prevent or eliminate a digestate safety hazard or reduce it to an acceptable level

3.16 co-operative

natural or legal persons who form a group under a written agreement, who exercise only agricultural, soil-/field-grown horticultural or forestry activities within the countries of the UK and who, as a group, carry out one AD process at one location within the co-operative's holdings

NOTE *See **3.37** for definition of "holding".*

3.17 corrective action

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

3.18 critical control point (CCP)

last 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

3.19 critical limit (CL)

criterion which separates acceptability from unacceptability

3.20 deviation

failure to meet a critical limit

3.21 digestate

whole digestate resulting from an AD process, and any subsequently separated fibre or liquor fractions

NOTE 1 *Includes any separated fibre that undergoes a subsequent aerobic maturation step, without addition of further materials.*

NOTE 2 *See definitions of terms "whole digestate" (**3.83**), "separated fibre (**3.64**) and separated liquor (**3.65**).*

3.22 digester

closed vessel system in which biodegradable materials decompose under anaerobic conditions

3.23 dirty water

dilute washings from dairy and milking parlours, and run-off from yard areas lightly contaminated by manure, slurry or used animal bedding

[derived from *Protecting our Water, Soil and Air – A Code of Good Agricultural Practice for farmers, growers and land managers* [5]]

3.24 domestic use (amateur horticulture)

use of digestates by members of the public in their own gardens

3.25 duty of care

responsibility of persons concerned with controlled waste to ensure that the waste is managed properly, is recovered or disposed of safely, does not cause harm to human 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 imports, produces, carries, keeps, treats or disposes of controlled waste or, as a broker, has control of such waste" [1], 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.*

3.26 exemption

exemption from the need to hold an authorization

NOTE *See **3.5** for definition of "authorization".*

3.27 farmer

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 an agricultural activity

NOTE 1 *A similar meaning is intended for any horticulturist who raises plants commercially on land used for a horticultural activity.*

NOTE 2 *See **3.40** for definition of "land manager".*

3.28 fit for purpose

material that does not have any properties or characteristics that prevent it from being suitable for its intended use(s)

NOTE *Where this term is applied to input material to an AD process, it means that such material has no physical or chemical properties that would prevent the digestate made from it from being fit for purpose. If depackaging is carried out by the digestate producer, a written supply of agreement for input materials would have to contain a declaration of "fit for purpose", which would limit the supplier's liabilities in terms of any properties that are affected by the AD process producer's depackaging step.*

3.29 flow diagram

systematic representation of the sequence of steps or operations used in the process for the production of whole digestate and any subsequently separated liquor or separated fibre

3.30 forestry

art and science of controlling the establishment, growth, composition, health and quality of forests used for cultivating trees, timber and woody biomass crops

NOTE *The definition includes plantations and systems other than forests.*

3.31 growing medium

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

[derived from PD CR 13456:1999]

3.32 harm

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

[derived from ISO/IEC Guide 51]

NOTE *In the context of this PAS, "harm" also includes injury or damage to the health of animals and plants. Harm can be caused by one or more unwanted biological, chemical or physical agents in, or by misuse of, whole digestate, separated liquor or separated fibre.*

3.33 hazard

potential source of harm

3.34 hazard analysis

process of collecting and evaluating information on hazards and conditions leading to their presence, to decide which are significant in relation to the production of digestates that can be used without harm

NOTE *This should be addressed in the HACCP plan.*

3.35 hazard analysis and critical control point (HACCP)

system used for the identification, evaluation and control of hazards that are significant in relation to the production of digestates that can be used without harm

3.36 HACCP plan

document prepared in accordance with HACCP principles, to ensure control of hazards that are significant in relation to the production, storage, supply and use of digestates that can be used without harm

3.37 holding

all the land units managed by a farmer/land manager within the UK

3.38 hydraulic retention time (HRT)

average time that material stays in the digester vessel, determined by the loading rate and operational digester capacity

NOTE *Hydraulic retention time can be calculated by dividing the digester working volume by the rate of flow of input materials into the digester, i.e. HRT (days) = digester volume (m^3) / influent flow rate (m^3 per day).*

3.39 input material

biodegradable material intended for feeding, or fed, into an AD process

NOTE *For the list of European Waste Catalogue input material types acceptable under the Anaerobic Digestate Quality Protocol (End of waste criteria for the production and use of quality outputs from anaerobic digestion of source-segregated biodegradable waste (ADQP)) [14], see this protocol's Appendix B.*

3.40 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

*NOTE See **3.27** for definition of "farmer".*

3.41 land reclamation

recovery of land from a brownfield or underutilized state to make it suitable for reuse, achieved through the stabilization, contouring, maintenance, conditioning, reconstruction and re-vegetation of the land

3.42 land remediation

process of making a site fit for purpose through the destruction, removal or containment of contaminants

NOTE Environmental damage can be ameliorated through the management, removal, sealing, treatment or stabilization of dangerous substances in order to make the site safe for a specific use, but not necessarily for all possible uses.

3.43 land restoration

includes land reclamation and land remediation

3.44 manure

slurries and solid manures, including farmyard manures and dirty water

NOTE This definition, from the Codes of Good Agricultural Practice *[5], [6], [7].*

3.45 maceration

to make biodegradable input materials into a more consistent and readily flowing and pumpable mixture by means of shredding, chopping, crushing or mincing the input materials and/or soaking them in a liquid

3.46 maturation

optional period of treatment or storage of separated fibre under predominantly aerobic conditions

3.47 matured

state of separated fibre that exhibits a low rate of biodegradation and which is unlikely to be phytotoxic when used as per good practice

3.48 mesophilic

organisms for which optimum growth temperatures are within the temperature range 30 °C to 45 °C

3.49 method of test

procedure for testing a sample of digestate

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

3.50 monitor

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

3.51 operating procedures

carried out and documented procedures for producing digestates

3.52 organic loading rate (OLR)

weight of organic matter fed to a unit volume of the digester per unit time

NOTE OLR = kg COD m^{-3} day^{-1} or kg VS m^{-3} day^{-1}, where COD is chemical oxygen demand and VS is volatile solids. A similar way to describe OLR is weight of organic dry matter added per day (kg VS d^{-1}) divided by digester volume (m^3).

3.53 pasteurization

process step during which the numbers of pathogenic bacteria, viruses and other harmful organisms in material undergoing AD are significantly reduced or eliminated by heating the material to a critical temperature for a minimum specified period of time

NOTE 1 Pasteurization could occur either as part of the AD process or as a separate step. Pasteurization does not aim to achieve sterilization, which destroys all life forms.

NOTE 2 Pasteurized material might contain beneficial and other, unharmful, microorganisms.

3.54 phytotoxic

substance that is toxic to plants

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

3.55 potentially toxic element (PTE)

chemical element that has potential to have toxic effects on humans, flora or fauna

NOTE *Lead, cadmium, chromium, mercury, copper, zinc and nickel are the seven PTEs included in* ***11.2*** *and* ***12.2*** *of this PAS.*

3.56 producer

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

3.57 putrescible

material that has the capability to become putrid

NOTE *In this context, those fractions of biowaste or biodegradable material with relatively high proportions of readily biodegradable carbon-based molecules and moisture.*

3.58 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, digestate sample test results and the effects of any corrective actions taken.*

3.59 quality management system (QMS)

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

[SOURCE: ISO 9000:2005]

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

3.60 Quality Protocol (QP)

set of criteria for the production, placement on the market, storage and use of products derived from suitable 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 might, under certain circumstances, be used without waste regulatory controls, in those countries in which the protocol applies

NOTE *A Quality Protocol also sets out how compliance with its criteria should be demonstrated. Products should be used in accordance with good practice, and appropriate guidance is referred to where available and suitable for use of those products in end markets allowed by that specific QP. Enquiries about QP applicability in a specific country should be addressed to its agency responsible for protecting the environment.*

3.61 risk

combination of the probability of occurrence of harm and the severity of that harm

[derived from ISO/IEC Guide 51]

NOTE *It can mean the potential realization of unwanted, adverse consequences to human life and health, property or the environment associated with a hazard.*

3.62 sanitary

degree of processing and biodegradation at which human, animal and plant pathogens present have been reduced to acceptable levels

3.63 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

3.64 separated fibre (SF)

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

NOTE *At least 15% of its mass should be dry matter in order that the sample is suitable for laboratory tests as a "solid" material. It should contain sufficient dry matter to be capable of being stacked in a heap if it undergoes an aerobic maturation step; a mass fraction of 23% fresh matter is a guideline figure.*

3.65 separated liquor (SL)

liquid fraction of material remaining after separating coarse fibres from whole digestate

NOTE *It is normally the fraction remaining following the use of a separator or centrifuge to remove coarse fibres. Less than 15% of its mass should be dry matter in order that the sample is suitable for laboratory tests as a "liquid" material. It should contain sufficient moisture to be pumpable; a suitable mass fraction percentage of dry matter content should be determined in practice and the dry matter result declared for any tested portion of production. If the user desires that no significant solids residue remains on crop leaves after applying separated liquor, it should contain no more than a mass fraction of 4% dry matter.*

3.66 sharps

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

NOTE *Organic components such as twigs and woody fragments can puncture skin but this risk is considered acceptably low and so has been omitted from this "sharps" definition. Omitted also are rock-derived "mineral" particles and aggregated particles of all sizes, including, for example, gravel and stones.*

3.67 soil improver/conditioner

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

[SOURCE: PD CR 13456:1999]

3.68 source-segregated

materials or biowastes that are stored, collected and not subsequently combined with any non-biodegradable wastes, or any potentially polluting or toxic materials or products, during treatment or storage (whether storage is before or after treatment)

NOTE *Source-segregated materials can include collection of a mixture of biowaste/biodegradable material types, from more than one source. Such materials do not include sewage sludges and their derivatives. It is acknowledged that low levels of physical contamination might occur, which might trigger rejection of an input material load or physical contaminant removal prior to loading the biowaste/biodegradable material into the working digester. See* ***6.1*** *regarding packaged biowastes/biodegradable materials.*

3.69 stability

quality of being stable

3.70 stable

point 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 *Stable digestate should not be attractive to vermin or wild animals and should not be so odorous that its storage or use causes nuisance to humans. In a stable but immature state, it might still contain insufficiently biodegraded natural or man-made substances that exert phytotoxic effects in some applications; this should be taken into account in guidelines for digestate use.*

3.71 stabilization

biological and chemical processes that, together with conditions in the material being treated, aim to achieve stable, treated material

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

3.72 step

point, procedure, operation or in the digestate chain, including raw materials, from primary production to final use of digestates and the consumption of food or fodder grown on land that has received such material

3.73 stones

extraneous, hard mineral matter greater than 5 mm in any dimension

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

3.74 supply agreement

agreement between an AD facility operator and a supplier of digestible input materials that specifies suitable material types, quality, options and actions to be taken in the event of contamination, and other criteria that facilitate input material control

3.75 thermophilic

organisms for which optimum growth temperatures are within the temperature range 45 °C to 80 °C

3.76 user

individual or organization that obtains digestates from a producer or third party with the intention of using them

3.77 validation, validate

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

NOTE 1 *In the context of PAS 110, this includes obtaining and evaluating evidence that the QMS is effective for producing digestates of the quality to which the producer has committed in the quality policy.*

NOTE 2 *See Clause 11 for validation requirements. It will take time to generate evidence of consistently sufficient digestate quality.*

3.78 verification, verify

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

3.79 volatile fatty acids (VFA)

fatty acids, or organic acids, with a carbon chain of six carbons or fewer

3.80 volatile solids (VS)

those solids in a sample of material that are lost on ignition of the dry solids at 550 °C

NOTE 1 *Volatile solids are also referred to as "loss on ignition (LOI)", which is a measure of organic matter (OM). See BS EN 15169 for the method of test.*

NOTE 2 *Dry solids are also referred to as "total solids (TS)", or "dry matter (DM)". See BS EN 14346 for the method of test.*

3.81 waste management licence (WML)

licence issued by the regulator, under the Environmental Protection Act 1990 (as amended) [1] and the Environmental Permitting (England and Wales) Regulations 2010 [8] in England and Wales and the Waste Management Licensing (Scotland) Regulations 2011 [10] in Scotland, that allows a person(s) or organization to undertake an activity involving the deposit, keeping, treating or disposal of a controlled waste

NOTE 1 *Regulators are the Environment Agency in England, Natural Resources Wales (was the Environment Agency Wales) in 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]. In England and Wales, WMLs were superseded by environmental permits in 2007 (see **3.5**).*

NOTE 2 *See **3.5** for definition of "authorization".*

3.82 waste regulatory controls

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

3.83 whole digestate (WD)

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

NOTE *Less than 15% of its mass should be dry matter in order that the sample is suitable for laboratory tests as a "liquid" material. It should contain sufficient moisture to be pumpable; a suitable mass fraction percentage of dry matter content should be determined in practice and the dry matter result declared for any tested portion of production.*

4 Quality management system (QMS)

4.1 General

NOTE *The requirements in PAS 110 cover those requirements in BS EN ISO 9001 that are relevant to the production of digestates that are fit for purpose, from a single AD process. For more information, producers should refer to BS EN ISO 9001, and also BS EN ISO 9000, which sets out QMS fundamentals and vocabulary (see Bibliography).*

4.1.1 A quality management system (QMS) specific to a defined digestion process and its resulting whole digestate, and any separated liquor and separated fibre, shall be established and maintained.

4.1.2 Digestates placed on the market shall be one or more of whole digestate, separated liquor or separated fibre, as determined appropriate by the producer. Any of these digestate output types placed on the market as conforming to PAS 110 shall conform to the requirements of this PAS.

NOTE *See Clause **3** for definitions of the terms "whole digestate", "separated liquor" and "separated fibre". The producer might choose to check the PAS 110 conformance of one or more of these digestate output types.*

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) ensure that responsibilities and authorities are defined, utilizing at least a staff organogram, and that these are communicated within the organization;

c) establish a quality policy for digestate produced under this QMS (see **4.2**);

d) communicate to the organization that the digestate produced under this QMS shall be fit for purpose [see **4.2.2** c) and **3.28**];

e) ensure that appropriate communication processes are established within the organization and that communication takes place regarding the effectiveness of the QMS; and

f) conduct management reviews.

4.1.4 Senior management shall appoint a member of the organization's management who, irrespective of other responsibilities, shall have responsibility and authority that includes:

a) ensuring that QMS processes are established, implemented and maintained;

b) reporting to senior management on the performance of the QMS and any need for improvement; and

c) ensuring the promotion of awareness of customer requirements throughout the organization.

NOTE *This role might fit well with the role of technical competence to operate a biowaste management facility, under an authorization. See **4.8** for requirements about review of the QMS.*

4.2 Quality policy

4.2.1 For each digestate output type for which PAS 110 conformance is claimed, or is intended to be claimed, the producer shall:

a) check whether digestate users have any requirements in addition to the minimum quality requirements set out in this PAS [see **4.2.2** c), **11.2** and **12.2**]; and

b) ensure that the market ready digestate is fit for purpose (see **3.28**), which includes meeting any extra quality requirements specified by the user.

NOTE *Apart from use as a soil improver/conditioner in a range of markets, it might be necessary to process whole digestate, separated liquor and separated fibre further to achieve suitable characteristics for specialist uses. Product fitness for purpose is the key aim of a QMS and why this PAS requires one.*

4.2.2 The producer's quality policy shall include:

a) clear identification of the location of the digestion site, the type(s) of processes employed, and what digestate output types (whole digestate and any separated fibre or separated liquid fractions) are produced;

b) for each digestate output type for which PAS 110 conformance is claimed, or is intended to be claimed, the producer's commitment to achieving the corresponding minimum quality specified in **11.2** and **12.2**; and

c) for each digestate output type for which PAS 110 conformance is claimed, or is intended to be claimed, the producer's commitment to fulfilling customers' requirements regarding its fitness for purpose.

4.3 Communication, awareness, training and competence

4.3.1 The quality policy and relevant parts of the QMS shall be communicated to all personnel whose activities affect digestate quality. They shall be made aware of the relevance and importance of their activities, and how those activities contribute to the achievement of the producer's commitments set out in its quality policy.

4.3.2 The producer (senior management and/or manager with QMS responsibilities) shall determine the necessary competences for personnel performing work affecting digestate quality.

4.3.3 Each person whose duties affect digestate quality shall be trained, instructed and supervised commensurate with those duties, such that he/she is competent. Training shall include the subjects of QMSs and HACCPs, at least for the competent person(s) with overall responsibility for the QMS, who also lead(s) or participate(s) in the HACCP team. That person's training on QMSs and HACCPs shall be carried out by a formal training provider.

4.3.4 For each person, including the competent person(s) with overall responsibility for the QMS, a record shall be kept of the:

a) training topic;
b) training date or period;
c) name and role of the person who received the training on that topic;
d) person and organization who delivered the training (which can be the producer); and
e) any certificate or qualification achieved.

4.4 Documents and document control

4.4.1 Documents appropriate to the scope of the QMS shall be established, used and subject to document control.

NOTE *Existing documentation and records may be used as part of the QMS if they meet the requirements of this PAS.*

4.4.2 Each document of internal origin that is in use within the QMS shall be the current version approved as adequate by the person with responsibility for document control. Each such document shall be legible, available at its relevant place(s) of use and include:

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

4.4.3 Records generated by a weighbridge system that relies on software programming which the producer is not easily or cost-effectively able to change are exempt from the requirements in **4.4.2**. This exemption is also conditional upon each weighbridge system record being assigned a unique record number.

4.4.4 Any document of external origin in use within the QMS shall be identified and its distribution shall be controlled.

4.4.5 Any obsolete document version shall be promptly removed from all places where it is used and, where appropriate, replaced with the current revised and approved version. Any obsolete document retained for any purpose shall be identified as obsolete.

4.4.6 The producer shall maintain records specified within this PAS that demonstrate effective control of input materials, production and storage of digestates.

4.4.7 The records shall be:

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

NOTE *Specific record types that PAS 110 requires to be established, and information they are required to include, are specified within other clauses in this PAS, in connection with the activity to be recorded.*

4.5 Incidents and accidents

The producer shall record all accidents and other incidents that occur on site, the known or suspected cause(s) and the actions taken. The need for preventive action shall be considered, and any such action taken shall be recorded.

4.6 Complaints and concerns

4.6.1 The producer shall decide and implement any necessary action in response to any complaints or concerns expressed by interested parties, including personnel, customers, clients and regulatory authorities, about quality or usability of the whole digestate, and any separated liquor and separated fibre fractions.

4.6.2 The producer 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 the concern or complaint was communicated to the producer and the 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(s) of any response to the person who expressed a concern or made a complaint; and
f) name of the person who communicated the response.

4.7 Internal audit of the QMS

4.7.1 The producer shall conduct and record internal audits at planned intervals, at least annually, to determine whether the QMS conforms to its QMS plan for the production of digestates that are fit for purpose, and whether the QMS is effectively implemented and maintained.

4.7.2 An audit programme shall be planned, taking 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. The 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.

4.7.3 Internal auditing shall cover QMS procedures (and processes), as well as evaluation of the digestate production process, the operating procedures that describe it and the digestate quality. Procedures relating to the allocation of QMS responsibilities, human resources, training, infrastructure, customer-related processes, data handling, communications and improvement of the QMS shall also be internally audited.

NOTE *PAS 110 includes numerous specific requirements relating to evaluation of the digestate production process and digestate quality, particularly in Clause* ***11*** *and Clause* ***12****.*

4.7.4 A procedure that defines the responsibilities and requirements for planning and conducting audits, establishing records and reporting results shall be established and documented.

4.7.5 The management responsible for the area being audited shall ensure that any necessary corrections and corrective actions are taken without undue delay to eliminate detected nonconformities and their causes. Follow-up activities shall include verification of the actions taken and reporting and recording of verification results.

4.8 Management review of the QMS

4.8.1 The producer's senior management shall review whether the QMS and HACCP plans continue to be effective.

4.8.2 A formal, recorded review shall be undertaken at least once per year, or sooner than scheduled if triggered by significant change before the scheduled date.

4.8.3 Inputs to each review shall include:

a) results of audits by the producer's personnel and any external auditors;
b) AD process performance;
c) digestate quality (i.e. its conformance to the quality policy, including fitness for purpose);
d) status of preventive and corrective actions;
e) follow-up actions from previous management reviews;
f) the continuing suitability of the QMS (including the HACCP plan, CCPs and CLs, and operating procedures) in relation to changing conditions and information;
g) any complaints and concerns expressed by interested parties, including personnel, customers, clients and regulatory authorities, and their outcomes;
h) recommendations for improvements.

4.8.4 The output from the management review shall include any decisions and actions related to:

a) improvement of the effectiveness of the QMS, including its procedures;
b) improvement of digestate quality as per customer/user requirements; and
c) resource needs.

4.8.5 If any significant, non-temporary, change in input materials, production process management or required digestate quality occurs, the production process shall be revalidated (see Note for guidance).

The significance 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 *to* ***4.8.2*** *and* ***4.8.5*** *Significant change is a matter of interpretation, and can relate to input materials, production process management, required digestate quality or other factors that affect its quality. If the producer has applied to a certification body for initial or renewal certification, an interpretation of the certification scheme rules may be sought.*

4.8.6 In the event of significant, temporary changes, the producer shall sample and test the relevant digestate output types (see Clause **11** if working towards validation, or Clause **12** if operating after validation), as appropriate, to determine the effects of those changes on the digestate(s).

5 Hazard analysis and critical control point (HACCP) planning

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, in order that digestates are safe to use and fit for purpose. For general guidance, refer to the Commission's relevant publications [15] and to organizations that own certification schemes and provide services for assessing compliance with PAS 110. Clause 5 covers HACCP planning within the context of digestate production and PAS 110's scope.

5.1 HACCP planning and activities shall be carried out in accordance with the Codex Alimentarius Commission's "Principles of the HACCP System" [15], namely:

- Principle 1 – conduct a hazard analysis (see **5.2**);
- Principle 2 – determine the Critical Control Points (CCPs) (see **5.3**);
- Principle 3 – establish critical limit(s) (CLs) (see **5.3**);
- Principle 4 – establish a system to monitor control of the CCPs (see Clause **7**, **11.1.2** and **12.1**);
- Principle 5 – establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control [i.e. is outside its CL(s); see **7.3.1** n)];
- Principle 6 – establish procedures for verification to confirm that the HACCP system is working effectively (see **5.6**, **11.1.2** and **12.1**); and
- Principle 7 – establish documentation concerning all procedures and records appropriate to these principles and their application (see **7.3.1**, **11.1.2**, **12.1**, **5.6** and **4.8**).

NOTE Source: See http://www.fao.org/DOCREP/005/Y1579E/y1579e03.htm#bm3.

5.2 A systematic assessment of human, animal and plant health hazards associated with intended uses of the digestate output type(s) for which PAS 110 conformance is claimed, or is intended to be claimed, shall be carried out. The hazards assessed shall include:

a) pathogens and toxins that adversely affect human and animal health;

b) odours offensive to people who live or work in close proximity to the location of use;

NOTE Input materials should be digested to such an extent that when digestate is spread as per good practice, by the producer or a different user, the activity does not release offensive odours that are deemed by the regulator or other relevant authority to be a "statutory nuisance".

a) stones and any man-made particles that might damage equipment for handling, mixing or applying digestate, or blended materials that contain it; and

b) sharps that might adversely affect human and animal health.

5.3 For hazard a) in **5.2**, one CCP in the digestate production process shall be identified and the CLs of the control measure(s) at the CCP shall be established. The same requirement applies to each further hazard specified in **5.2** and any other hazards identified by the producer.

*NOTE All steps of the digestate production process, from input material receipt to digestate dispatch, should be considered when identifying the CCP for a specific hazard. This does not mean that every step in the production process is a CCP. More than one control measure might be required to control a specific hazard and more than one hazard might be controlled by a specific control measure. "Acceptable level" (see **3.15** and **3.18**) means achieving at least the minimum quality required in this PAS for digestates and any additional criteria that the producer has committed to meeting in the quality policy.*

5.4 All whole digestate shall undergo the CCP(s) for each hazard applicable to whole digestate. At each CCP, operating conditions shall be monitored and maintained within the CCP's CLs.

*NOTE Hazards **5.2** a) to d) inclusive apply, as well as any others the producer has identified relevant to whole digestate.*

This requirement shall apply both during and after process validation.

5.5 For each CCP applicable to separated fibre or separated liquor, for which PAS 110 conformance is claimed, operating conditions shall be monitored and maintained within the CCP's CLs.

*NOTE Clause **9** of this PAS specifies requirements relating to monitoring. Checks on whether the process is operating within the defined CLs are required in **11.1.2** and **12.1.1**. See **7.3.1**'s requirement to define*

corrective action(s) that should be taken in the event that a CL is exceeded.

5.6 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 and reviewed as part of the QMS review, as instructed in **4.8**.

NOTE *Requirements relating to complaints are specified in **4.6** and a review of complaints is required in **4.8**, as part of the QMS review.*

6 Input materials

6.1 Input materials shall be source segregated (see **3.68**) biowastes (see **3.8**) and/or source segregated biodegradable materials. Reasonable care shall be taken to avoid any contaminated wastes, products or materials from becoming included with the input materials.

Packaged former foodstuffs, catering wastes, other types of ABP and non-ABP food wastes shall only be accepted for pre-treatment, by the producer, if they conform to the input materials supply agreement (see **6.2**). The pre-treatment shall use reasonable endeavours to remove non-biodegradable packaging prior to loading those biowastes/biodegradable materials into the digestion system.

NOTE 1 *Risk assessment may necessitate exclusion of biowastes/biodegradable materials packaged in glass. See Clause **5**, which requires HACCP planning. In a country which has adopted the ADQP, if PAS 110 digestate is used as a product in that country or any other country which has adopted the ADQP, it may only be derived from the ADQP's list of allowed input material types and sources.*

NOTE 2 *Evidence of the following may be sufficient to fulfil the pre-treatment requirements:*

- *machinery in place that is capable of removing non-biodegradable packaging;*
- *a staff member competent in operating the machinery;*
- *machinery is working effectively and that a staff member is responsible for checking it regularly;*
- *regular servicing of the machinery in line with the servicing schedule.*

6.2 A written supply agreement for the input materials shall be agreed with each input material supplier, before any loads are delivered, unless the source is from within the digestate producer's own premises or holding. The agreement shall include:

a) the type and specific source location(s) of the material;

b) a brief description of the source type(s) and any associated process from which it arose (e.g. for food waste, "dedicated collection for this commercial, municipal waste types from retail outlets";

c) a brief description of its physical form (e.g. typical percentage of total solids or moisture content, and whether it is pumpable);

d) criteria for input material delivery acceptance, which may be qualitative (e.g. by visual assessment) or quantitative (e.g. by testing samples), or both;

e) any additional arrangements associated with actions that would be taken to remove or reduce physical contaminants or any other unsuitable content prior to shredding or digestion;

f) criteria that trigger input material rejection and the procedure to be followed if rejected;

NOTE *Criteria that could trigger input material delivery rejection include the material being of a type not included in the producer's authorization, or physical contaminants being present at levels that would adversely affect the digestion process and that cannot be removed cost-effectively.*

g) a requirement for duty of care on the supplier relating to quality control;

h) a requirement that any significant change in the quality of input material will be notified to the producer before delivery; and

i) declarations that each input material type from each source covered by the supply agreement is fit for purpose.

NOTE *See **3.28** and, in particular, its Note.*

6.3 As an exception to the requirements in **6.2**, a written supply agreement shall not be required where a farming/horticultural/forestry co-operative (see **3.16**) produces digestate from only manure, unprocessed crops, processed crops, crop residues and/or used animal bedding that arises within the co-operative's premises or holdings. This exception is also conditional upon the co-operative's digestate being used entirely within the same co-operative's premises or holdings.

Under the circumstances described in **7.2.5**, exception to the requirements in **6.2** is only allowed if input material from any source outside the producer's premises or holding is manure, unprocessed crops, processed crops, crop residues, glycerol and/or used animal bedding that has arisen within the premises or holdings of the co-operative of which the producer is part.

6.4 Before use, the animal bedding (see **6.3**) may come from a different premises or holding, provided that it has not come into contact with livestock other than those within the premises or holding where it is to be used as animal bedding. Such material shall not contain any non-biodegradable materials or residues of any toxic substances that represent unacceptable risk to human or animal health, or the environment, before and after digestion.

NOTE *Examples of non-biodegradable materials are veneer, paint and laminate. Many wood preservatives contain toxins, residual amounts of which can be detected when the treated wood is discarded after use. Requirements under this PAS do not allow the use of treated wood, even if used as, or in, animal bedding.*

6.5 The producer shall ensure that each supplier of input materials understands the importance and requirements of the input materials supply agreement.

6.6 For each vehicle's load of input material delivered, the producer shall make and keep a record of the:

a) input material type(s) and European Waste Catalogue code(s) (see Note to **3.39**);
b) source;
c) amount;
d) date delivered;
e) acceptance; and
f) delivery location on site.

NOTE *For example, this might be the number of the tank into which the input material is discharged.*

6.7 The only exception to the requirement in **6.6** f) is when the producer's site only has one delivery location and it is identified in the operating procedures, or elsewhere in QMS documentation.

6.8 Each delivery of input material shall be visually inspected at a location where there is no risk that the delivery will cross-contaminate any other input materials accepted for treatment, any materials undergoing treatment or any fully treated materials in storage. The only exception is for a delivery that cannot be visually inspected without unacceptable risk to human health, after all practicable measures have been taken into account.

NOTE *Visual inspection should be at the point of acceptance or after the load has been discharged, as appropriate to the facility layout and its digestion system. See **7.1.1** for a further requirement on the prevention of cross-contamination.*

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

a) input material type(s) and European Waste Catalogue code(s) (see Note to **3.39**);
b) source;
c) amount;
d) date rejected;
e) reason for rejection; and
f) where it was sent.

6.10 Exception to the requirements in **6.9** a), b) and e) shall be allowed for the periodic container loads of physical contaminants removed from numerous accepted input material deliveries that are sent to a disposal facility.

NOTE *The sources of the physical contaminants [**6.9** b)] and reason for rejection [**6.9** e)] 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. Re-recording the input material type(s) and European Waste Catalogue code(s) [**6.9** a)] is also not necessary because the load consigned for disposal consists of physical contaminants and is not an input material to the AD process.*

7 Process management, separation and storage

7.1 General

NOTE *An appropriate mix of suitable input materials and the maintenance of an effective AD process with a sufficient hydraulic retention time (HRT, see **3.38**) for the volumetric solids load to the system are the most important factors for producing digestates of consistent and adequate quality. The organic loading rate (OLR, see **3.52**) is an operating term that the producer can use to work out a suitable balance between the maximum loading rate and the minimum necessary HRT in the digester(s). Apart from the input material characteristics and capacity of the AD vessel(s), the OLR will also be influenced by the operational temperature CLs and any mixing of the material while undergoing AD.*

7.1.1 The input materials, and the process and steps used to make the whole digestate and any separated liquor and separated fibre fractions, and their stores, shall be kept separate from any other materials, processes and stores on the same site.

7.1.2 The site, digestate production system, storage and dispatch of treated and rejected materials shall be designed and managed such that:

a) rejected materials and any materials being stored awaiting rejection do not contaminate any other materials on site;

b) material suitable for treatment flows one way through the system;

c) partially treated material is not contaminated by untreated or recontaminated material; and

d) fully treated whole digestate, and any separated liquor or separated fibre, is not contaminated by untreated, partially treated or recontaminated material.

NOTE *Digestate may be recirculated through one or more steps in the AD process, as appropriate for process optimization or efficient use of liquid resources.*

7.1.3 If any one of the digestate output types does not conform to PAS 110 (see **4.1.2**), the producer shall ensure that digestate that conforms to PAS 110 is not contaminated by digestate that does not conform to PAS 110 or any other material at the production facility.

7.1.4 Each treatment and storage vessel and area shall be clearly labelled, and correspond with the production process described in the document system, including the process flow diagram.

7.1.5 Each batch or portion of production shall be assigned a unique code, for quality management purposes.

7.1.6 All digestate shall have been fully processed and completed any minimum applicable maturation or storage time before dispatch for use.

NOTE *Covered storage at the AD facility will minimize the risk of recontamination of digestates with pathogens and, in conjunction with appropriate odour controls, will reduce gaseous emissions (e.g. ammonia and methane) from the digestates to the environment. Covers might influence the impact on digestate of climatic factors, such as rainfall, in the dilution, wetting and slumping of product.*

7.2 Pasteurization step

7.2.1 With the exception of AD processes approved by the competent authority under the EU Animal by-products Regulation [3], and which treat all materials to the standard approved by the competent authority, all digestates shall be produced by an AD process that includes:

a) a pasteurization step capable of heating all material to at least 70 °C for one hour; or

b) an equivalent alternative treatment validated for its efficacy at reducing a suitable plant pathogen indicator species.

7.2.2 Input materials derived from prior processes including thermal treatment(s) equivalent to at least 70 °C for one hour, are exempt from the requirements of **7.2.1**.

7.2.3 Digestates made only from manure, unprocessed crops, processed crops, crop residues, glycerol and/or used animal bedding that arise within a single or co-operative's (see **3.16**) premises or holding and, after digestion, are returned to, and used entirely within, the same premises or holding are exempt from the requirements of **7.2.1**.

NOTE *The regulator's relevant position statement or briefing note should be checked regarding the circumstances in which waste regulatory controls do*

not apply to agricultural manures and slurries, and crops grown specifically for AD.

7.2.4 Before use, the animal bedding referred to in **7.2.3** is allowed to come from a different premises or holding, provided that it has not come into contact with livestock other than those within the premises or holding where it is to be used as animal bedding. Such material shall not contain any non-biodegradable materials or residues of any toxic substances that represent unacceptable risk to human or animal health, or the environment, before and after digestion.

NOTE *Examples of non-biodegradable materials are veneer, paint and laminate. Many wood preservatives contain toxins, residual amounts of which can be detected when the treated wood is discarded after use. Requirements under this PAS do not allow the use of treated wood, even if used as, or in, animal bedding.*

7.2.5 Exemption from the pasteurization step (**7.2.1**) is also allowed for manure, unprocessed crops, processed crops, crop residues, glycerol and/or used animal bedding (see **7.2.4** for allowed source before use) that arises within a single or co-operative's (see **3.16**) premises or holding, if such input materials are co-digested with pasteurized biowastes/biodegradable materials from any source(s) outside the premises or holding. This material source-specific exemption from pasteurization is conditional upon all the digestate being used within the originating single or co-operative's premises or holding, in a way consistent with the single premises or holding or co-operative's animal health plan.

7.3 Documents on process management, separation and storage

7.3.1 The producer shall write and implement operating procedures that cover as a minimum:

a) a written description and annotated flow diagram of the digestate production system;
b) input material storage;
c) reception area;
d) any input material preparation prior to digestion (e.g. pasteurization, cleaning, maceration);
e) the steps for producing digestates at the digestion facility;
f) which steps consist of, or include, control measures that represent a CCP and the CLs (operating conditions/parameters) of each CCP;

NOTE *The CLs should take account of the maximum OLR (see **3.52**) that is effective for achieving sufficient quality of the digestates, given the minimum HRT used (see **3.38**).*

g) the monitoring points and parameters monitored;
h) any applicable step for separating whole digestate;
i) storage of whole digestate and/or separated liquor, and any applicable storage conditions and minimum timescales;
j) any maturation step and storage for separated fibre;
k) any recirculation of whole digestate or separated liquor;
l) the digestate sampling points;
m) process management evaluation;
n) corrective actions to be followed in the event of deviation from CLs at any CCP (i.e. if any CL is exceeded), quality failure of a sampled portion of production, or any other occurrence that causes, or might cause, quality failure;
o) dispatch of digestates from the digestion facility;
p) process inspection and maintenance, from acceptance of input materials to dispatch of digestates and rejected materials;
q) procedures to be followed in the event of system failure, equipment failure and accidents or incidents that affect the digestion process or the quality of digestates;
r) a procedure for establishing the corrective action(s) appropriate for a previously unforeseen circumstance that does, or could, result in digestate quality failure(s);
s) control of vermin; and
t) a statement of the known or estimated input material throughput and quantities of digestate output types for the past 12-month period.

NOTE 1 *The operating procedures take account of the HACCP plan and other requirements of this PAS. To avoid duplication, wherever appropriate producers should cross-reference specific parts of an authorization, exemption, ABP document, working plan, the HACCP plan or other current documents.*

NOTE 2 *It is recommended that the producer establishes and implements a plan for minimizing and managing odours that arise at the AD facility. Odour minimization and its emissions are within the regulator's remit to check and enforce legal requirements. Compliance with PAS 110 cannot confer immunity from legal obligations (see Foreword and **0.3**). This PAS does not set controls on digestate production odours; however, **5.2** b) sets a related requirement.*

NOTE 3 *The list above does not necessarily cover all actions that should be recorded within QMS documents, so it should be carefully reviewed by the producer. Parts of the system relating to biogas, and its treatment and conversion to renewable energy, are*

not included in the list above as this PAS only covers those parts of the system that affect digestate quality. The producer's QMS documents may, for completeness, cover biogas aspects, including any biogas quality criteria set by the producer.

Emergency response procedures are amongst the requirements of the waste management licensing, environmental permitting and pollution prevention and control regulations [8, 9, 10, 11,12].

7.3.2 The producer shall record all actions taken relating to operation of the AD process.

8 Process equipment

8.1 The producer's document system shall identify the equipment required to maintain and monitor the process.

8.2 The producer's document system shall state how often equipment shall be checked, what checks shall be carried out and the contingency arrangements in the event of equipment failure. The results of each check shall be recorded.

***NOTE** to **8.1** and **8.2** For example, this information could be included in the operating procedures document or others specifically about equipment.*

8.3 The producer shall maintain in good working order all equipment required to manage and monitor the digestion process.

9 Process monitoring

9.1 General

***NOTE** Monitoring is a planned sequence of observations or measurements of control parameters to assess whether a CCP (see **3.18**) is under control (see **3.14**). CCPs and CLs (see **3.19**) for AD systems operated as per good practice should minimize odorous and potentially polluting gaseous emissions, minimize variation in digestate quality, and consistently produce digestates that are safe to use and fit for purpose. The health and safety of personnel is covered by regulations, so is not within the scope of this PAS.*

9.1.1 The producer's document system shall state the:

a) monitoring points, including which are for CL parameters;
b) parameters monitored and calculated (e.g. temperature, OLR and HRT);
c) monitoring methods;
d) frequency of monitoring and calculating parameters;
e) acceptable range of results for each monitored parameter; and
f) information that shall be recorded.

9.1.2 The producer shall monitor the process steps and keep process monitoring records that include: monitoring results, corresponding dates and identification of the relevant monitoring points.

10 Sampling of digestates

10.1 General sampling

10.1.1 Sampling of whole digestate, separated liquor or separated fibre as required in Clause **10** shall only be applicable to the digestate output types that are, or are intended to be, placed on the market as conforming to PAS 110.

10.1.2 Sampling for measurement of all determinants shown in Table 1 to Table 5, except for digestate stability (Annex A), shall be carried out as described in **10.2** to **10.4**.

10.1.3 Sampling for measurement of digestate stability (Annex A) shall be carried out at the end of the digestion process and prior to dispatch of digestate from the site of production.

10.2 Whole digestate shall be sampled after full treatment, when it is ready for use. Each final sample shall be representative of the batch or portion of production (see **3.6**) sampled.

NOTE *If a minimum storage period does not apply to whole digestate, sampling upon completion of full treatment may be done via one or more sampling access points appropriately located in the digestate production system. If a minimum storage period is necessary before the whole digestate is ready for use, it should be sampled after it has completed the minimum storage period and preferably before any more recently produced whole digestate enters the same storage tank. If sampled from a storage tank, thorough mixing should immediately precede sampling. Regarding animal by-products, see* ***10.5****.*

10.3 Separated liquor shall be sampled after full treatment and separation from whole digestate, when it is ready for use. Each final sample shall be representative of the batch(es) or portion(s) of production sampled.

NOTE *See the Note to* ***10.2*** *for guidance also applicable to separated liquor.*

10.4 Separated fibre shall be sampled after full treatment and separation from whole digestate, and after any maturation step and/or a minimum storage period under any conditions that the producer has deemed applicable (see **7.3.1**). Each final sample shall be representative of the batch(es) or portion(s) of production sampled.

NOTE 1 *It is recommended that separated fibre undergoes a maturation step before sampling. Maturation should achieve significant loss of the free ammonia that separated fibre contains when separated from whole digestate. Free ammonia can impair plant germination and growth. Regarding animal by-products, see* ***10.5****.*

NOTE 2 *to* ***10.2****,* ***10.3*** *and* ***10.4*** *See* ***11.2*** *and* ***12.2*** *for minimum required sampling and testing frequencies for process validation and afterwards.*

NOTE 3 *to* ***10.2****,* ***10.3*** *and* ***10.4*** *The competent authority or regulator, or an appropriate certification scheme owner, certification body, consultant or AD system manufacturer/supplier may provide guidance on how to obtain a representative sample from a batch or portion of production of whole digestate or separated liquor. BS EN 12579,* Soil improvers and growing media – Sampling *provides guidance on how to obtain a representative sample of separated fibre. To obtain a representative sample of whole digestate or separated liquor, it is recommended that producers follow the guidance in the adapted version of Bundesgütemeinschaft Kompost e.V.'s "Sampling liquid digested materials" document [see Further Reading].*

10.5 Any sample taken and the test results obtained for the purposes of the EU Animal by-products Regulation [3] shall only count as evidence towards compliance with this PAS if the sample is taken as required in Clause **10** of this PAS, and is tested as required in **11.2** before validation, or as required in **12.2** after validation. In particular, the sample shall be taken at a time that corresponds with **10.2**'s, **10.3**'s or **10.4**'s respective criteria for whole digestate, separated liquor or separated fibre.

10.6 The minimum time between taking each representative sample for a batch or portion of production shall be defined in the producer's QMS. Each sample shall represent a different batch or portion of production.

NOTE *The producer should consider a number of factors to ensure a different batch or portion of production is sampled each time. These include the minimum necessary HRT, OLR and digestion vessel configuration (single, series or parallel). See* ***3.6*** *for a definition of a batch or portion of production.*

10.7 For each sample, the producer shall record, keep a copy of and inform the laboratory of the:

a) sampling date;

b) sample type (whole digestate, separated liquor or separated fibre, as applicable);

c) code for, or reference to, the sampled batch or portion of production;

d) digestion facility name; and

e) name of the person who carried out the sampling.

10.8 The requirement in **10.7** also applies to any sample taken by any party other than the producer, who may record sampling and supply information to the laboratory on the producer's behalf.

10.9 Each sample tested in order to demonstrate compliance with this PAS shall be tested by a laboratory that has no conflict of interest with the producer.

11 Validation

11.1 General

11.1.1 The characteristics and proportions of input materials might vary. Consequently, the validation timescale shall be sufficient for checks that any whole digestate, separated liquor or separated fibre output types for which PAS 110 conformance is claimed meet the requirements of this PAS.

11.1.2 In order to validate the efficacy of the elements of the HACCP plan and verify that the digestion process is under control (as per the HACCP plan) and achieving the required digestate quality results, the producer shall:

a) ensure that the quality and proportions of input materials are within the plant design and operation parameters;

b) operate all of the CCPs within their CLs;

c) check that monitoring results show that the process is performing as planned, particularly at the CCPs;

d) if there is deviation beyond any CL, carry out corrective action in time to avoid adverse changes in output quality;

e) where feasible, identify the cause when a CCP operates outside of its CLs or a quality failure occurs, and record the cause and the corrective action taken;

f) send samples of whole digestate and any separated liquor and separated fibre fractions, for testing, as specified in **11.2**;

g) check that test results of whole digestate, and any separated liquor or separated fibre fractions, conform to the corresponding minimum quality requirements specified in **11.2** and any additional specifications the producer has committed to meeting in the quality policy [see **4.2.2** c)], i.e. the digestate is fit for purpose;

h) change the HACCP plan if the process is under control (the CCPs are operating within their CLs) but is not producing sufficient quality whole digestate, separated liquor and/or separated fibre; and

i) repeat **11.1.2** a) to **11.1.2** g) inclusive if **11.1.2** h) is carried out.

NOTE *Requirements in **11.1.2** f) and **11.1.2** g) apply to those digestate output types for which PAS 110 conformance is intended to be claimed, or is claimed.*

11.1.3 Before validation, a claim of PAS 110 conformance to minimum quality requirements shall only be made in connection with the sampled portion(s) of digestate if the test results of the corresponding sample demonstrate that it is at least the minimum quality required in this PAS and it meets any additional quality characteristics the producer has committed to meeting in the quality policy.

11.2 Minimum testing of the digestate and quality requirements for validation

11.2.1 The production process and any one or more whole digestate, separated liquor or separated fibre output types for which PAS 110 conformance is claimed shall be validated as in accordance with **11.2.2** to **11.2.6**. When achieved, validation shall be recorded.

11.2.2 For each parameter in Table 1, the three most recent digestate sample test results shall not exceed the corresponding upper limit. This requirement applies to each digestate output type for which PAS 110 conformance is claimed (whole digestate, separated fibre and/or separated liquor).

11.2.3 An exception to **11.2.2**'s "three most recent" requirement shall be allowed for whole digestate derived from ABPs if its quality, in terms of human and animal pathogen indicator species, is validated by the competent authority/Animal Health vet, provided that the samples are taken as required in Clause **10**. The same is allowed for separated fibre and separated liquor derived from ABPs.

NOTE 1 *ABP regulations [3] require five samples to be tested in terms of human and animal pathogen indicator species. Upper limits for some sample test results might not match those set in this PAS for non-ABP digestates, according to whether sampling and testing is for the purpose of process monitoring or checking digestate quality.*

NOTE 2 *This means that if a digestion process produces separated fibre and separated liquor, as well as whole digestate, and the producer claims PAS 110 conformance for each digestate type, if the competent authority/Animal Health vet has only specified and checked the production and quality of the whole digestate, the separated fibre and separated liquor are subject to PAS 110's requirements in **11.2.1**, **11.2.2** and **10.5**. It is anticipated that in most cases the competent authority/Animal Health vet would evaluate each digestate type.*

Table 1 – Test parameters, upper limit values and declaration parameters for validation

Parameter	Method of test	Upper limit and unit
Pathogens (human and animal indicator species) in WD/SL/SF		
ABP digestate: human and animal pathogen indicator species	As per appropriate ABP regulation or any other method approved by the competent authority/Animal Health vet/Veterinary Service vet	As specified by the competent authority/Animal Health vet/Veterinary Service vet in the "approval in principal" or "full approval"
Non-ABP digestate: *E. coli*	SCA MSS Part 3A [N1] or BS ISO 16649-2	1,000 CFU/g fresh matter
Non-ABP digestate: *Salmonella spp.*	Method as specified by appropriate ABP regulation, according to nation in which digestate is produced, or SCA MSS Part 4A [N2]	Absent in 25 g fresh matter
Potentially toxic elements (PTE) in WD/SL/SF		
Liquid (≤ 15% TS) digestates	For all PTEs [4]: BS EN ISO 15587-1:2002	Declare on a fresh weight basis
Fibre (> 15% TS) digestates	For all PTEs [4] except Hg: BS EN 13650:2001 For Hg: BS ISO 16772	Declare on a fresh weight basis

Total nitrogen (N)	**kg/t**	**Less than 1**	**1 to 1.9**	**2 to 2.9**	**3 to 3.9**	**4 to 4.9**	**5 to 5.9**	**6 to 6.9**	**7 to 7.9**	**8 to 8.9**	**9 or more**
Cadmium (Cd)	mg/kg	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.2
Chromium (Cr)	mg/kg	8	16	24	32	40	48	56	64	72	80
Copper (Cu)	mg/kg	16	32	48	64	80	96	112	128	144	160
Mercury (Hg)	mg/kg	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
Nickel (Ni)	mg/kg	4	8	12	16	20	24	28	32	36	40
Lead (Pb)	mg/kg	16	32	48	64	80	96	112	128	144	160
Zinc (Zn)	mg/kg	32	64	96	128	160	192	224	256	288	320

Stability of WD/SL/SF		
Details of stability testing methods and requirements are shown in Annex A.		
Physical contaminants in WD/SL/SF		
Stones > 5 mm	NRM method JAS-497/001 [N3]	Declare on a fresh weight basis
Total glass, metal, plastic and any "other" non-stone, man-made fragments > 2 mm	NRM method JAS-497/001 [N3]	Declare on a fresh weight basis

[4] "All PTEs" means Cd, Cr, Cu, Ni, Pb, Hg and Zn.

Table 1 – Test parameters, upper limit values and declaration parameters for validation *(continued)*

Total nitrogen (N)	**kg/t**	**Less than 1**	**1 to 1.9**	**2 to 2.9**	**3 to 3.9**	**4 to 4.9**	**5 to 5.9**	**6 to 6.9**	**7 to 7.9**	**8 to 8.9**	**9 or more**
Total stones	kg/t	3.2	6.4	9.6	12.8	16	19.2	22.4	25.6	28.8	32
Total physical contaminants (excluding stones)	kg/t	0.04	0.07	0.11	0.14	0.18	0.22	0.25	0.29	0.32	0.36
No "sharps" (see Note to **6.1**)											

NOTE 1 *Total nitrogen is the limiting factor for PTE and physical contaminant contents. For example, a total nitrogen content of between 2 and 2.9kg/t means that Cd could not exceed 0.36mg/kg, and stones could not exceed 9.6kg/t. Methods for testing total nitrogen are listed below in this table.*

NOTE 2 *Separated liquor is exempt from physical contaminants tests only if the separation technology used by the producer results in all particles being < 2 mm in the separated liquor fraction.*

Parameter	Method of test	Declaration and unit
Characteristics of WD/SL/SF for declaration, without limit values, that influence application rates		
pH value	BS EN 13037	Declare as part of typical or actual characteristics
Total nitrogen (N)	BS EN 13654-1 (Kjeldahl) or BS EN 13654-2 (Dumas) Test to be applied to fresh digestate only, without drying	Declare as part of typical or actual characteristics, units as appropriate (e.g. kg t^{-1} fresh weight)
Total phosphorus (P)	For liquid (≤ 15% TS) digestates: BS EN ISO 15587-1:2002	
	For fibre (> 15% TS) digestates: BS EN 13650	
Total potassium (K)	For liquid (≤ 15% TS) digestates: BS EN ISO 15587-1:2002	
	For fibre (> 15% TS) digestates: BS EN 13650	
Ammoniacal nitrogen (NH_4-N), extractable in potassium chloride	SOP Z/004 [N4] or SOP JAS-083 [N5]	
Dry matter (also referred to as "total solids")	BS EN 14346	Declare as part of typical or actual characteristics, mass fraction percentage of fresh sample
Loss on ignition (also referred to as "volatile solids" and a measure of organic matter)	BS EN 15169	Declare as part of typical or actual characteristics, units as appropriate

NOTE 1 *PAS 110 does not require testing and declaration of digestate particle size. If such information is desired, the maximum particle size and the > 2 mm particle size distribution of digestate can be tested according to the method "Kapitel II. A 3.1, 1. Lfg. 9/2006, BGK" [see Further Reading].*

NOTE 2 *PAS 110 does not require testing and declaration of all water soluble nutrients and elements. If further nutrient and element information is desired, digestate can be tested according to the method in BS EN 13652 (see Bibliography).*

11.2.4 Table 2 provides an alternative to Table 1 for digestate made only from manure, unprocessed crops, processed crops, crop residues, glycerol and/or used animal bedding that arises within the producer's/co-operative's premises or holding. The digestate shall be used entirely within the same premises or holding.

11.2.5 Before use, the animal bedding referred to in **11.2.4** may come from a different premises or holding, provided that it has not come into contact with livestock other than those within the premises or holding where it is to be used as animal bedding. Such material shall not contain any non-biodegradable materials or residues of any toxic substances that represent unacceptable risk to human or animal health, or the environment, before and after digestion.

Examples of non-biodegradable materials are veneer, paint and laminate. Many wood preservatives contain toxins, residual amounts of which can be detected when the treated wood is discarded after use. Requirements under this PAS do not allow the use of treated wood, even if used as, or in, animal bedding.

11.2.6 In the case of digestates made from input materials arising within a single or co-operative's (see **3.16**) premises or holding, and that are entirely used within the same premises or holding, the human and animal pathogen indicator species tests are only required if any input material contains, or is at risk of containing, human and/or animal pathogens.

Table 2 – Test parameters, upper limit values and declaration parameters for validation of digestates made from the producer's/co-operative's own materials and used by the producer/co-operative

Parameter	Method of test	Upper limit and unit
Pathogens (human and animal indicator species) in WD/SL/SF		
ABP digestate: human and animal pathogen indicator species	As per appropriate ABP regulation or any other method approved by the competent authority/ Animal Health vet/Veterinary Service vet	As specified by the competent authority/Animal Health vet/Veterinary Service vet in the "approval in principal" or "full approval"
Non-ABP digestate: *E. coli*	SCA MSS Part 3A [N1] or BS ISO 16649-2	1,000 CFU/g fresh matter
Non-ABP digestate: *Salmonella spp.*	Method as specified by appropriate ABP regulation, according to nation in which digestate is produced, or SCA MSS Part 4A [N2]	Absent in 25 g fresh matter
Potentially toxic elements (PTE) in WD/SL/SF		
Liquid (≤ 15% TS) digestates	For all PTEs [5]: BS EN ISO 15587-1:2002	Declare on a fresh weight basis
Fibre (> 15% TS) digestates	For all PTEs [5] except Hg: BS EN 13650:2001 For Hg: BS ISO 16772	Declare on a fresh weight basis

[5] "All PTEs" means Cd, Cr, Cu, Ni, Pb, Hg and Zn.

Table 2 – Test parameters, upper limit values and declaration parameters for validation of digestates made from the producer's/co-operative's own materials and used by the producer/co-operative *(continued)*

Total nitrogen (N)	**kg/t**	**Less than 1**	**1 to 1.9**	**2 to 2.9**	**3 to 3.9**	**4 to 4.9**	**5 to 5.9**	**6 to 6.9**	**7 to 7.9**	**8 to 8.9**	**9 or more**
Cadmium (Cd)	mg/kg	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.2
Chromium (Cr)	mg/kg	8	16	24	32	40	48	56	64	72	80
Copper (Cu)	mg/kg	16	32	48	64	80	96	112	128	144	160
Mercury (Hg)	mg/kg	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
Nickel (Ni)	mg/kg	4	8	12	16	20	24	28	32	36	40
Lead (Pb)	mg/kg	16	32	48	64	80	96	112	128	144	160
Zinc (Zn)	mg/kg	32	64	96	128	160	192	224	256	288	320

Stability of WD/SL/SF		
Details of stability testing methods and requirements are shown in Annex A.		
Parameter	**Method of test**	**Declaration and unit**
Characteristics of WD/SL/SF for declaration, without limit values, that influence application rates		
pH value	BS EN 13037	Declare as part of typical or actual characteristics
Total nitrogen (N)	BS EN 13654-1 (Kjeldahl) or BS EN 13654-2 (Dumas) Test to be applied to fresh digestate only, without drying	Declare as part of typical or actual characteristics, units as appropriate (e.g. kg t^{-1} fresh weight)
Total phosphorus (P)	For liquid (≤ 15% TS) digestates: BS EN ISO 15587-1:2002	
	For fibre (> 15% TS) digestates: BS EN 13650	
Total potassium (K)	For liquid (≤ 15% TS) digestates: BS EN ISO 15587-1:2002	
	For fibre (> 15% TS) digestates: BS EN 13650	
Ammoniacal nitrogen (NH_4-N), extractable in potassium chloride	SOP Z/004 ([N4] or SOP JAS-083 [N5]	
Dry matter (also referred to as "total solids")	BS EN 14346	Declare as part of typical or actual characteristics, mass fraction percentage of fresh sample
Loss on ignition (also referred to as "volatile solids" and a measure of organic matter)	BS EN 15169	Declare as part of typical or actual characteristics, units as appropriate

NOTE 1 *PAS 110 does not require testing and declaration of digestate particle size. If such information is desired, the maximum particle size and the > 2 mm particle size distribution of digestate can be tested according to the method "Kapitel II. A 3.1, 1. Lfg. 9/2006, BGK" [see Further Reading].*

NOTE 2 *PAS 110 does not require testing and declaration of all water soluble nutrients and elements. If further nutrient and element information is desired, digestate can be tested according to the method in BS EN 13652 (see Bibliography).*

12 After validation

12.1 General

12.1.1 The producer shall continue to monitor and evaluate process efficacy and digestate quality by:

a) maintaining operations within the validated CLs for each CCP;

b) continuing to monitor and record process conditions and management as specified in Clause **9**;

c) sending samples of whole digestate and any separated liquor and separated fibre fractions for testing, as specified in **12.2**;

d) checking that test results of any whole digestate, separated liquor and separated fibre for which PAS 110 conformance is claimed continue to conform to the corresponding minimum quality requirements specified in **12.2** and any additional specifications the producer has committed to meeting in the quality policy (see **4.2.2** c)), i.e. the digestate is fit for purpose;

e) taking corrective action in the event of: any CCP operating outside of its CLs, a quality failure of a sampled batch or portion of production, or any other occurrence that causes, or might cause, quality failure; and

f) where feasible, identifying the cause when a CCP operates outside of its CLs or a quality failure occurs, and recording the cause and the corrective action taken.

12.1.2 In the event of **12.1.1** e), if there is concern or certainty that digestate quality has been adversely affected, testing of a representative sample of the affected batch or portion of production shall be undertaken, as appropriate for determining the efficacy of the corrective action.

NOTE *Such circumstances might include resampling and retesting a batch or portion of production.*

12.2 Minimum testing of the digestate and quality requirements after validation

12.2.1 Minimum frequencies for testing representative samples of digestate after validation shall be applied as presented in Table 4.

12.2.2 For each parameter in Table 3, the three most recent digestate sample test results shall not exceed the corresponding upper limit.

NOTE 1 *This requirement in **12.2.1** applies to each digestate output type for which PAS 110 conformance is claimed (whole digestate, separated fibre and/or separated liquor).*

NOTE 2 *It is not a requirement to test each digested material output type for stability (see **10.1.3**).*

NOTE 3 *For each batch or portion of production from which a sample is not taken for testing, the records of input materials accepted, management of the AD process, any applicable additional process steps and storage periods, and any corrective actions taken in the event of deviation(s) from CLs are the indirect evidence that the producer should evaluate to determine whether that batch or portion of production conforms to this PAS.*

12.2.3 An exception to **12.2.2**'s "three most recent" requirement shall be allowed for whole digestate derived from ABPs on condition that its quality, in terms of human and animal pathogen indicator species, is validated by the competent authority/Animal Health vet, and on condition that the samples are taken as required in Clause **10**. The same is allowed for separated fibre and separated liquor derived from ABPs.

NOTE *ABP regulations require five samples to be tested in terms of human and animal pathogen indicator species. Upper limits for some sample test results might not match those set in this PAS for non-ABP digestates, according to whether sampling and testing is for the purpose of process monitoring or checking digestate quality "during or on withdrawal from storage at the biogas plant". Consequently, this PAS allows ABP requirements to take precedence, subject to taking each sample as specified in Clause **10**.*

Table 3 – Minimum digestate testing and quality requirements after validation

Parameter	Method of test	Upper limit and unit
Pathogens (human and animal indicator species) in WD/SL/SF		
ABP digestate: human and animal pathogen indicator species	As per appropriate ABP regulation or any other method approved by the competent authority/ Animal Health vet/Veterinary Service vet	As specified by the competent authority/ Animal Health vet/ Veterinary Service vet in the "approval in principal" or "full approval"
Non-ABP digestate: *E. coli*	SCA MSS Part 3A [N1] or BS ISO 16649-2	1,000 CFU/g fresh matter
Non-ABP digestate: *Salmonella spp.*	Method as specified by appropriate ABP regulation, according to nation in which digestate is produced, or SCA MSS Part 4A [N2]	Absent in 25 g fresh matter
Potentially toxic elements (PTE) in WD/SL/SF		
Liquid (≤ 15% TS) digestates	For all PTEs [6]: BS EN ISO 15587-1:2002	Declare on a fresh weight basis
Fibre (> 15% TS) digestates	For all PTEs [6] except Hg: BS EN 13650:2001 For Hg:BS ISO 16772	Declare on a fresh weight basis

Total nitrogen (N)	**kg/t**	**Less than 1**	**1 to 1.9**	**2 to 2.9**	**3 to 3.9**	**4 to 4.9**	**5 to 5.9**	**6 to 6.9**	**7 to 7.9**	**8 to 8.9**	**9 or more**
Cadmium (Cd)	mg/kg	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.2
Chromium (Cr)	mg/kg	8	16	24	32	40	48	56	64	72	80
Copper (Cu)	mg/kg	16	32	48	64	80	96	112	128	144	160
Mercury (Hg)	mg/kg	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
Nickel (Ni)	mg/kg	4	8	12	16	20	24	28	32	36	40
Lead (Pb)	mg/kg	16	32	48	64	80	96	112	128	144	160
Zinc (Zn)	mg/kg	32	64	96	128	160	192	224	256	288	320

Stability of WD/SL/SF		
Details of stability testing methods and requirements are shown in Annex A.		
Physical contaminants in WD/SL/SF		
Stones > 5 mm	NRM method JAS-497/001 [N3]	Declare on a fresh weight basis
Total glass, metal, plastic and any "other" non-stone, man-made fragments > 2 mm	NRM method JAS-497/001 [N3]	Declare on a fresh weight basis

[6] "All PTEs" means Cd, Cr, Cu, Ni, Pb, Hg and Zn.

Table 3 – Minimum digestate testing and quality requirements after validation *(continued)*

Total nitrogen (N)	**kg/t**	**Less than 1**	**1 to 1.9**	**2 to 2.9**	**3 to 3.9**	**4 to 4.9**	**5 to 5.9**	**6 to 6.9**	**7 to 7.9**	**8 to 8.9**	**9 or more**
Total stones	kg/t	3.2	6.4	9.6	12.8	16	19.2	22.4	25.6	28.8	32
Total physical contaminants (excluding stones)	kg/t	0.04	0.07	0.11	0.14	0.18	0.22	0.25	0.29	0.32	0.36
No "sharps" (see 3.66 and 6.1)											

NOTE 1 *Total nitrogen is the limiting factor for PTE and physical contaminant contents. For example, a total nitrogen content of between 2 and 2.9kg/t means that Cd could not exceed 0.36mg/kg, and stones could not exceed 9.6kg/t. Methods for testing total nitrogen are listed below in this table.*

NOTE 2 *Separated liquor is exempt from physical contaminants tests only if the separation technology used by the producer results in all particles being < 2 mm in the separated liquor fraction.*

Parameter	Method of test	Declaration and unit
Characteristics of WD/SL/SF for declaration, without limit values, that influence application rates		
pH value	BS EN 13037	Declare as part of typical or actual characteristics
Total nitrogen (N)	BS EN 13654-1 (Kjeldahl) or BS EN 13654-2 (Dumas) Test to be applied to fresh digestate only, without drying	Declare as part of typical or actual characteristics, units as appropriate (e.g. kg t^{-1} fresh weight)
Total phosphorus (P)	For liquid (≤ 15% TS) digestates: BS EN ISO 15587-1:2002	
	For fibre (> 15% TS) digestates: BS EN 13650	
Total potassium (K)	For liquid (≤ 15% TS) digestates: BS EN ISO 15587-1:2002	
	For fibre (> 15% TS) digestates: BS EN 13650	
Ammoniacal nitrogen (NH_4-N), extractable in potassium chloride	SOP Z/004 [N4] or SOP JAS-083 [N5]	
Dry matter (also referred to as "total solids")	BS EN 14346	Declare as part of typical or actual characteristics, mass fraction percentage of fresh sample
Loss on ignition (also referred to as "volatile solids" and a measure of organic matter)	BS EN 15169	Declare as part of typical or actual characteristics, units as appropriate

NOTE 1 *PAS 110 does not require testing and declaration of digestate particle size. If such information is desired, the maximum particle size and the > 2 mm particle size distribution of digestate can be tested according to the method "Kapitel II. A 3.1, 1. Lfg. 9/2006, BGK" [see Further Reading].*

NOTE 2 *PAS 110 does not require testing and declaration of all water soluble nutrients and elements. If further nutrient and element information is desired, digestate can be tested according to the method in BS EN 13652 (see Bibliography).*

Table 4 – Minimum frequencies for testing representative samples of digestate after validation

Parameter	Minimum frequencies for testing representative samples
If ABP digestate: human and animal pathogen indicator species	As specified by the competent authority/ Animal Health vet/ Veterinary Service vet in the "approval in principal" or "full approval"
If non-ABP digestate: *E. coli*	1 per 5,000 m^3 of WD/SF/SL produced, or 1 per 3 months, whichever is the soonest
If non-ABP digestate: *Salmonella spp.*	1 per 5,000 m^3 of WD/SF/SL produced, or 1 per 3 months, whichever is the soonest
Potentially toxic elements (PTE)	1 per 6,000 m^3 of WD/SF/SL produced, or 1 per 3 months, whichever is the soonest
Stability	2 per 12 months and not within 3 months of each other, or sooner if and when significant change occurs (see 4.8.5)
Physical contaminants	1 per 6,000 m^3 of WD/SF/SL produced, or 1 per 3 months, whichever is the soonest
Total nitrogen (N), total phosphorus (P) and total potassium (K)	1 per 6,000 m^3 of WD/SF/SL produced, or 1 per 3 months, whichever is the soonest
Ammoniacal nitrogen (NH_4-N)	1 per 6,000 m^3 of WD/SF/SL produced, or 1 per 3 months, whichever is the soonest
Dry matter (total solids)	1 per 6,000 m^3 of WD/SF/SL produced, or 1 per 3 months, whichever is the soonest
Loss on ignition (volatile solids or a measure of organic matter)	1 per 6,000 m^3 of WD/SF/SL produced, or 1 per 3 months, whichever is the soonest

12.2.4 Table 5 provides an alternative to Table 3 for digestate made only from manure, unprocessed crops, processed crops, crop residues, glycerol and/ or used animal bedding that arises within a single or co-operative's) (see **3.16**) premises or holding. The digestate shall be used entirely within the same premises or holding.

12.2.5 Before use, the animal bedding referred to in **12.2.4** may come from a different premises or holding, provided that it has not come into contact with livestock other than those within the premises or holding where it is to be used as animal bedding. Such material shall not contain any non-biodegradable materials or residues of any toxic substances that represent unacceptable risk to human or animal health, or the environment, before and after digestion.

NOTE *Examples of non-biodegradable materials are veneer, paint and laminate. Many wood preservatives contain toxins, residual amounts of which can be detected when the treated wood is discarded after use. Requirements under this PAS do not allow the use of treated wood, even if used as, or in, animal bedding.*

Table 5 – Test parameters and upper limit values for use after validation of digestates made from the producer's/co-operative's own materials and used by the producer/co-operative

Parameter	Method of test	Upper limit and unit
Pathogens (human and animal indicator species) in WD/SL/SF		
ABP digestate: human and animal pathogen indicator species	As per appropriate ABP regulation or any other method approved by the competent authority/Animal Health vet/Veterinary Service vet	As specified by the competent authority/Animal Health vet/Veterinary Service vet in the "approval in principal" or "full approval"
Non-ABP digestate: *E. coli*	SCA MSS Part 3A [N1] or BS ISO 16649-2	1,000 CFU/g fresh matter
Non-ABP digestate: *Salmonella spp*.	Method as specified by appropriate ABP regulation, according to nation in which digestate is produced, or SCA MSS Part 4A [N2]	Absent in 25 g fresh matter
Potentially toxic elements (PTE) in WD/SL/SF		
Liquid (≤ 15% TS) digestates	For all PTEs [7]: BS EN ISO 15587-1:2002	Declare on a fresh weight basis
Fibre (> 15% TS) digestates	For all PTEs [7] except Hg: BS EN 13650:2001 For Hg: BS ISO 16772	Declare on a fresh weight basis

Total nitrogen (N)	**kg/t**	**Less than 1**	**1 to 1.9**	**2 to 2.9**	**3 to 3.9**	**4 to 4.9**	**5 to 5.9**	**6 to 6.9**	**7 to 7.9**	**8 to 8.9**	**9 or more**
Cadmium (Cd)	mg/kg	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.2
Chromium (Cr)	mg/kg	8	16	24	32	40	48	56	64	72	80
Copper (Cu)	mg/kg	16	32	48	64	80	96	112	128	144	160
Mercury (Hg)	mg/kg	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
Nickel (Ni)	mg/kg	4	8	12	16	20	24	28	32	36	40
Lead (Pb)	mg/kg	16	32	48	64	80	96	112	128	144	160
Zinc (Zn)	mg/kg	32	64	96	128	160	192	224	256	288	320

NOTE *Total nitrogen is the limiting factor for PTE contents. For example, a total nitrogen content of between 2 and 2.9kg/t means that Cd could not exceed 0.36mg/kg. Methods for testing total nitrogen are listed below in this table.*

Stability of WD/SL/SF
Details of stability testing methods and requirements are shown in Annex A.

[7] "All PTEs" means Cd, Cr, Cu, Ni, Pb, Hg and Zn.

Table 5 – Test parameters and upper limit values for use after validation of digestates made from the producer's/co-operative's own materials and used by the producer/co-operative *(continued)*

Parameter	Method of test	Declaration and unit
Characteristics of WD/SL/SF for declaration, without limit values, that influence application rates		
pH value	BS EN 13037	Declare as part of typical or actual characteristics
Total nitrogen (N)	BS EN 13654-1 (Kjeldahl) or BS EN 13654-2 (Dumas) Test to be applied to fresh digestate only, without drying	Declare as part of typical or actual characteristics, units as appropriate (e.g. kg t^{-1} fresh weight)
Total phosphorus (P)	For liquid (≤ 15% TS) digestates: BS EN ISO 15587-1:2002	
	For fibre (> 15% TS) digestates: BS EN 13650	
Total potassium (K)	For liquid (≤ 15% TS) digestates: BS EN ISO 15587-1:2002	
	For fibre (> 15% TS) digestates: BS EN 13650	
Ammoniacal nitrogen (NH_4-N), extractable in potassium chloride	SOP Z/004 [N4] or SOP JAS-083 [N5]	
Dry matter (also referred to as "total solids")	BS EN 14346	Declare as part of typical or actual characteristics, mass fraction percentage of fresh sample
Loss on ignition (also referred to as "volatile solids" and a measure of organic matter)	BS EN 15169	Declare as part of typical or actual characteristics, units as appropriate

NOTE 1 *PAS 110 does not require testing and declaration of digestate particle size. If such information is desired, the maximum particle size and the > 2 mm particle size distribution of digestate can be tested according to the method "Kapitel II. A 3.1, 1. Lfg. 9/2006, BGK" [see Further Reading].*

NOTE 2 *PAS 110 does not require testing and declaration of all water soluble nutrients and elements. If further nutrient and element information is desired, digestate can be tested according to the method in BS EN 13652 (see Bibliography).*

13 Actions in the event of test result failure

13.1 If any tested sample fails any one or more of the applicable limits specified in **11.2** before validation or **12.2** after validation, the producer shall:

a) dispatch the sampled batch or portion of production as non-conforming material; or

b) take appropriate corrective action and gain evidence of conformance to this PAS before dispatching it for use.

13.2 Any extra sampling and testing carried out on a failed batch or portion of production shall correspond with the failure parameter(s).

13.3 If a sample representative of all the whole digestate or separated liquor in a storage tank fails a test and the producer chooses to take corrective action, then following implementation of the corrective action, an additional batch or portion of production of digestate that has completed its minimum necessary HRT in the digester (see 10.6) may be pumped into the tank. After thorough mixing, a sample representative of the tank's content may be sampled for testing. The producer shall take its test results into account when evaluating conformance to **11.2**'s requirements for validation or **12.2**'s requirements for after validation.

13.4 If a sample representative of a batch or portion of production of separated fibre fails a test and the producer chooses to take corrective action, that batch or portion of production shall be resampled after the corrective action and before any other batch or portion of production of separated fibre is added to it. Its stability (see Table A.1) and pathogen indicator species test results shall not be taken into account when evaluating conformance to **11.2**'s requirements for validation or **12.2**'s requirements for after validation.

13.5 After validation, if any tested sample fails any one or more of the applicable limits specified in **12.2** and the sampled batch or portion of production has been dispatched for use before the test results are evaluated, the producer shall inform the digestate customer(s) and appropriate regulator and/or competent authority of the nature of the failure.

NOTE *Any digested, controlled wastes that do not conform to this PAS, and the ADQP in any country in which it applies, might 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 by the producer would be subject to waste regulatory controls. Results from any further tests, including any on an archived portion of a sample from the same batch or portion of production, might be taken into account when deciding whether waste regulatory controls apply or enforcement action should be taken. Consequently, it is strongly recommended that any sampled batch or portion of production is not dispatched for use until after the test results have been checked for conformance to PAS 110.*

13.6 Before validation, any test result pass associated with the circumstances described in **13.3** or **13.4** that is allowed to be taken into account when evaluating conformance to **11.2**'s requirements for validation shall be regarded as the first of the "three most recent" sample test result passes required in those clauses (note the exceptions allowed in **11.2.3**, **11.2.5** and **11.2.6**). The additional batches or portions of production that are required to be sampled, tested and evaluated in order to validate the efficacy of the production process shall be sampled and tested promptly.

13.7 After validation, any test result pass associated with the circumstances described in **13.3** or **13.4** that is allowed to be taken into account when evaluating conformance to **12.2**'s requirements for after validation shall be regarded as the first of the "three most recent" sample test result passes required in those clauses (note the exceptions allowed in **12.2.3** and **12.2.5**). The additional batches or portions of production that are required to be sampled, tested and evaluated in order to demonstrate the continued efficacy of the production process shall be sampled and tested promptly.

14 Labelling, marking, dispatch and use of whole digestate, separated liquor and separated fibre

14.1 General

14.1.1 The producer shall record the amount, type, date and location of where any batch or portion of production of digestate is used within the producer's premises or holding. This requirement also applies to any batch or portion of production of digestate used within the premises or holdings of the co-operative of which the farm with the digester is part.

If digestate has been exempted from pasteurization requirements related to production within a co-operative (see **7.2.3, 7.2.5** and **3.16**), then those receiving such digestate shall be alerted to the omission of a pasteurization step, and agree, in writing, that the digestate is of sufficient quality for their purpose.

NOTE 1 *The other requirements in Clause **14** do not apply to any batch or portion of production used within the producer's premises or holding, nor to any batch or portion of production produced by a farming/horticultural/forestry co-operative from its own biodegradable materials, as specified in this PAS, that is used within the same farming/horticultural/forestry co-operative.*

NOTE 2 *Omission of a pasteurization step might affect specific phytohygiene management arrangements, which should be taken into account when using digestates exempted from pasteurization requirements.*

NOTE 3 *Check the regulator's relevant position statement or briefing note regarding the circumstances in which waste regulatory controls do not apply to agricultural manures and slurries, and crops grown specifically for AD.*

14.1.2 For each consignment of whole digestate, separated liquor or separated fibre that conforms to this PAS, which is dispatched for a use other than disposal, the producer shall supply the following information to the customer as a document, or as part of a document:

a) producer name and contact details;

b) digestate process address, or process identification code, if code is matched with process elsewhere in the QMS documents;

c) statement of whether whole digestate, separated liquor or separated fibre is supplied;

d) statement of the approximate particle size range of the whole digestate, separated liquor or separated fibre supplied;

NOTE *This can be the producer's qualitative assessment of the digestate, e.g. 0 mm to 10 mm for separated fibre.*

e) typical characteristics, or laboratory test results, if all or part of the sampled batch or portion of production is supplied;

f) if derived in whole or in part from ABP material, that it contains or consists of treated ABP material and a warning that the user will have committed an offence if the EU Animal by-products Regulation' [3] requirements are not complied with; and

NOTE *Attention is drawn to the requirements of the EU Animal by-products Regulation [3]. These encompass the placement of digestates made from catering waste or other ABP on the market, and include: Livestock grazing ban periods after spreading such materials, the records that should be made and kept by the user, and obligations associated with any trans-frontier shipment of ABP wastes, whether treated or untreated.*

g) the statement: "Conforms to PAS 110:2014".

NOTE *Marking "PAS 110:2014" on, or in relation to, whole digestate, separated liquor or separated fibre represents a producer's declaration of conformity, i.e. a claim by, or on behalf of, the producer 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, which is recommended.*

NOTE 1 *to **14.1.2** For farmers and land managers, the information should include a recommendation that the digestate is used in accordance with the relevant Codes of Good Agricultural Practice [5 for England, 6 for Wales and 7 for Scotland], and any documents that supersede them.*

NOTE 2 *to **14.1.2** For any consignment of digestate that does not conform to this PAS and which is dispatched for disposal or a suitable use as a low-quality material, the producer is to supply information*

to the customer and make and keep a copy of each consignment record, as required in the appropriate regulations. The Environmental Permitting (England and Wales) Regulations 2010 [8] and duty of care requirements apply in the case of controlled biowastes, and the EU Animal by-products Regulation [3] includes requirements regarding placement of treated ABP on the market.

14.1.3 Separated fibre supplied for domestic use (amateur horticulture) is exempt from **14.1.2** e)'s requirement.

NOTE *The ADQP [14] does not allow the use of digestate for domestic use (amateur horticulture) (e.g. matured separated fibre as a growing medium ingredient). Growing media are precisely formulated, taking account of the characteristics of all bulky substrates and other ingredients. In any country where the ADQP does not apply, matured separated fibre can be used in a growing medium if it conforms to PAS 110's requirements and any further ones specified by the growing media manufacturer, e.g. matured and tested with results that demonstrate conformance to the manufacturer's quality specification.*

14.1.4 The producer shall make and keep a copy of the record for each consignment of whole digestate, separated liquor or separated fibre, which shall include:

a) the customer name and contact details, or customer identification code, if codes are matched with customer details elsewhere in the QMS documents, and the delivery address;
b) quantity dispatched, by weight or volume; and
c) date of dispatch.

14.1.5 Information supplied to each digestate customer shall include the typical characteristics or laboratory test results corresponding with the batch or portion of production dispatched, and include:

a) PTE concentrations;
b) pH value;
c) total nitrogen;
d) total phosphorus;
e) total potassium;
f) ammoniacal nitrogen (NH4-N);
g) dry matter (also referred to as "total solids"); and
h) loss on ignition (also referred to as "volatile solids" and a measure of organic matter).

NOTE *An appropriate certification scheme owner, certification body or consultant may be contacted for guidance on achieving additional parameter test results that users of digestates might want to know, and templates for records of digestates dispatched for use.*

Annex A (normative)
Minimum anaerobic digestate stability requirements

A.1 General

Table A.1 sets out the compliance requirement for stability determination as required in this PAS, in Table 1, Table 2, Table 3 and Table 5.

Alternative methods for determining stability as set out in Table A.1 may be used, where those alternatives demonstrate an equivalent limit to that set in the table.

Table A.1 – Anaerobic digestate stability requirement, test parameter and upper limit value

Parameter	Method of test	Upper limit and unit [A)]
Stability of whole digestate, separated liquor or separated fibre		
Residual biogas potential (RBP)	OFW004-005 [N6]	0.45 l biogas/g volatile solids
[A)] Assessment of RBP test pass or fail shall use the average of the triplicate RBP values that each sample test generates.		
NOTE *The concentration of volatile fatty acids (VFA) in a sample may be determined ahead of an RBP test. If a digestate sample's VFA result exceeds 0.774 g COD/g VS, this might indicate that the sample will fail a subsequent RBP test. VFAs may be determined by gas chromatography.*		

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 3882:2007, *Specification for topsoil and requirements for use*

BS EN 12579, *Soil improvers and growing media – Sampling*

BS EN 13040, *Soil improvers and growing media – Sample preparation for chemical and physical tests, determination of dry matter content, moisture content and laboratory compacted bulk density*

BS EN 13652, *Soil improvers and growing media – Extraction of water soluble nutrients and elements*

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

BS EN ISO 9000:2005, *Quality management systems – Fundamentals and vocabulary*

BS EN ISO 9001:2008, *Quality management systems – Requirements*

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

CEN/TC BT 151 WI weeds 2007-03-13(E). *A method to assess viable weed seeds and plant propagules in soils, sludges and treated biowastes.* STD Version 2.1c. European Committee for Standardization (CEN)

NOTE *Digestate samples can be tested for viable weed seeds and propagules, using this draft CEN method. PAS 110 does not require such testing of digestates because the reproducibility and repeatability of this method of test has not been assessed.*

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

PAS 100, *Specification for composted materials*

PD CR 13456:1999, *Soil improvers and growing media – Labelling, specifications and product schedules*

Other publications

[1] GREAT BRITAIN. Environmental Protection Act 1990 (as amended). London: HMSO.

[2] GREAT BRITAIN. The Waste (England and Wales) Regulations 2011. SI 2011 No. 988. London: (TSO) The Stationery Office.

[3] EUROPEAN COMMUNITIES. Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 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). OJ L 300, 14.11.2009, p.1. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:300:0001:0033:EN:PDF.

[4] EUROPEAN COMMUNITIES. Commission Regulation (EU) No 142/2011 of 25 February 2011 implementing Regulation (EC) No 1069/2009 of the European Parliament and of the Council laying down health rules as regards animal by-products and derived products not intended for human consumption and implementing Council Directive 97/78/EC as regards certain samples and items exempt from veterinary checks at the border under that Directive. OJ L 54, 26.2.2011, p.1. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:054:0001:0254:EN:PDF.

[5] DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS (DEFRA). *Protecting our Water, Soil and Air – A Code of Good Agricultural Practice for farmers, growers and land managers.* Norwich: TSO (The Stationery Office), 2009. ISBN 978 0 11 243284 5.[8)]

[6] WELSH ASSEMBLY GOVERNMENT. *The Code of Good Agricultural Practice For the Protection of Water, Soil and Air for Wales* (2011 No.20).

[7] SCOTTISH EXECUTIVE. *Prevention of Environmental Pollution from Agricultural Activity, A Code of Good Practice* (PEPFAA Code). Edinburgh: Scottish Executive, 2005.

[8)] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268691/pb13558-cogap-131223.pdf

[8] GREAT BRITAIN. The Environmental Permitting (England and Wales) Regulations 2010. SI 2010 No. 675 (and as amended). London: (TSO) The Stationery Office.

[9] SCOTLAND. The Pollution Prevention and Control (Scotland) Regulations 2012. SSI 2012 No. 360. London: (TSO) The Stationery Office.

[10] SCOTLAND. The Waste Management Licensing (Scotland) Regulations 2011. SSI 2011 No. 228. London: (TSO) The Stationery Office.

[11] NORTHERN IRELAND. The Waste Management Licensing Regulations (Northern Ireland) 2003. SRNI 2003 No. 493. London: TSO (The Stationery Office).

[12] NORTHERN IRELAND. The Pollution Prevention and Control Regulations (Northern Ireland) 2003. SRNI 2003 No. 46. London: (TSO) The Stationery Office.

[13] EUROPEAN COMMUNITIES. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. OJ L 312, 22.11.2008, p. 3 (Framework Directive on Waste). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:en:PDF.

[14] ENVIRONMENT AGENCY. *Anaerobic Digestate Quality Protocol. End of waste criteria for the production and use of quality outputs from anaerobic digestion of source-segregated biodegradable waste*. 2010. [Waste Protocols Project, Anaerobic Digestate Quality Protocol (ADQP)].

[15] CODEX. Basic Texts On Food Hygiene Codex Alimentarius. Rome: FAO, 2003. http://www.fao.org/DOCREP/005/Y1579E/y1579e03.htm#bm3.

Further reading

BUNDESGÜTEMEINSCHAFT KOMPOST e.V. (Maximum grain size and composition of grain size) Maximale Korngrösse und Korngrössenzusammensetzung, Methodenbuch zur Analyse organischer Düngemittel, Bodenverbesserungsmittel und Substrate, Kapitel (chapter) II. A 3.1, 1. Lfg. 9/2006. Cologne: Bundesgütemeinschaft Kompost e.V, 2006.

BUNDESGÜTEMEINSCHAFT KOMPOST e.V. [Adapted] (Sampling liquid digested materials). Probennahme von flüssigen Stoffen, Methodenbuch zur Analyse organischer Düngemittel, Bodenverbesserungsmittel und Substrate, Kapitel I., A 2. Cologne: Bundesgütemeinschaft Kompost e.V, 2007.

NOTE *This guideline procedure is an adaptation of the Bundesgütemeinschaft Kompost e.V's instructions. It is available from organizations that own certification schemes and services for assessing compliance with PAS 110.*

EUROPEAN COMMISSION, Health & Consumer Protection Directorate-General. *Guidance document, Implementation of procedures based on the HACCP principles, and facilitation of the implementation of the HACCP principles in certain food businesses*. Brussels, 2005. [9)]

ANIMAL HEALTH AND VETERINARY LABORATORIES AGENCY (AHVLA). *AHVLA Guidance on Composting and Biogas (Anaerobic Digestion) of Animal By-products in Approved Plants for Industry.* 2012.

[9)] http://ec.europa.eu/food/food/biosafety/hygienelegislation/guidance_doc_haccp_en.pdf.

British Standards Institution (BSI)

BSI is the independent national body responsible for preparing British Standards and other standards-related publications, information and services. It presents the UK view on standards in Europe and at the international level.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

Revisions

British Standards and PASs are periodically updated by amendment or revision. Users of British Standards and PASs should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using British Standards would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Similarly for PASs, please notify BSI Customer Services.

Tel: +44 (0)20 8996 9001 Fax: +44 (0)20 8996 7001

BSI offers BSI Subscribing Members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of British Standards and PASs.

Tel: +44 (0)20 8996 7669 Fax: +44 (0)20 8996 7001
Email: plus@bsigroup.com

Buying standards

You may buy PDF and hard copy versions of standards directly using a credit card from the BSI Shop on the website **www.bsigroup.com/shop**. In addition all orders for BSI, international and foreign standards publications can be addressed to BSI Customer Services.

Tel: +44 (0)20 8996 9001 Fax: +44 (0)20 8996 7001
Email: orders@bsigroup.com

In response to orders for international standards, BSI will supply the British Standard implementation of the relevant international standard, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Knowledge Centre.

Tel: +44 (0)20 8996 7004 Fax: +44 (0)20 8996 7005
Email: knowledgecentre@bsigroup.com

BSI Subscribing Members are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration.

Tel: +44 (0)20 8996 7002 Fax: +44 (0)20 8996 7001
Email: membership@bsigroup.com

Information regarding online access to British Standards and PASs via British Standards Online can be found at **http://shop.bsigroup.com/bsol**

Further information about British Standards is available on the BSI website at **www.bsigroup.com/standards**

Copyright

Tel: +44 (0)20 8996 7070
Email: copyright@bsigroup.com

BSI, 389 Chiswick High Road
London W4 4AL
United Kingdom
www.bsigroup.com

9 780580 826610