COMMISSION IMPLEMENTING DECISION (EU) 2017/302

of 15 February 2017

establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the intensive rearing of poultry or pigs

(notified under document C(2017) 688)

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) ([1]), and in particular Article 13(5) thereof,

Whereas:

(1) Best available techniques (BAT) conclusions are the reference for setting permit conditions for installations covered by Chapter II of Directive 2010/75/EU and competent authorities should set emission limit values which ensure that, under normal operating conditions, emissions do not exceed the emission levels associated with the best available techniques as laid down in the BAT conclusions.

(2) The forum composed of representatives of Member States, the industries concerned and non-governmental organisations promoting environmental protection, established by Commission Decision of 16 May 2011 ([2]), provided the Commission on 19 October 2015 with its opinion on the proposed content of the BAT reference document for the intensive rearing of poultry or pigs. That opinion is publicly available.

(3) The BAT conclusions set out in the Annex to this Decision are the key element of that BAT reference document.

(4) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 75(1) of Directive 2010/75/EU,

HAS ADOPTED THIS DECISION:

Article 1

The best available techniques (BAT) conclusions for the intensive rearing of poultry or pigs, as set out in the Annex, are adopted.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 15 February 2017.

For the Commission

Karmenu VELLA

Member of the Commission

([1]) OJ L 334, 17.12.2010, p. 17.

([2]) OJ C 146, 17.5.2011, p. 3.

ANNEX

BAT CONCLUSIONS FOR THE INTENSIVE REARING OF POULTRY OR PIGS

SCOPE

These BAT conclusions concern the following activities specified in Section 6.6 of Annex I to Directive 2010/75/EU, namely '6.6. Intensive rearing of poultry or pigs':

(a) with more than 40 000 places for poultry

(b) with more than 2 000 places for production pigs (over 30 kg), or

(c) with more than 750 places for sows.

In particular, these BAT conclusions cover the following on-farm processes and activities:

— nutritional management of poultry and pigs;

— feed preparation (milling, mixing and storage);

— rearing (housing) of poultry and pigs;

— collection and storage of manure;

— processing of manure;

— manure landspreading;

— storage of dead animals.

These BAT conclusions do not address the following processes or activities:

— disposal of dead animals; this may be covered in the BAT conclusions on Slaughterhouses and Animal By-products Industries (SA).

Other BAT conclusions and reference documents which are of relevance for the activities covered by these BAT conclusions are the following:

Reference documents	Activity
Waste Incineration (WI)	Incineration of manure
Waste Treatment Industries (WT)	Composting and anaerobic digestion of manure
Monitoring of emissions from IED-installations (ROM)	Monitoring of emissions to air and water
Economics and Cross-media Effects (ECM)	Economics and cross-media effects of techniques
Emissions from Storage (EFS)	Storage and handling of materials
Energy Efficiency (ENE)	General aspects of energy efficiency
Food, Drink and Milk Industries (FDM)	Feed production

Where these BAT conclusions address manure storage and landspreading, this is without prejudice to the provisions of Council Directive 91/676/EEC ([1]).

([1]) Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (OJ L 375, 31.12.1991, p. 1).

Where these BAT conclusions address the storage and disposal of dead animals and manure processing and landspreading this is without prejudice to the provisions of Regulation (EC) No 1069/2009 of the European Parliament and of the Council ([1]).

These BAT conclusions apply without prejudice to other relevant legislation, e.g. on animal welfare.

DEFINITIONS

For the purposes of these BAT conclusions, the following definitions apply.

Term used	Definition
Ad libitum	The provision of free access to feed or water thereby allowing the animal to self-regulate intake according to its biological needs.
Animal place	Space provided per animal in a housing system taking into account the maximum capacity of the plant.
Conservation tillage	Any method of soil cultivation that leaves the previous year's crop residue (such as corn stalks or wheat stubble) on fields before and after planting the next crop, to reduce soil erosion and run-off.
Existing farm	A farm which is not a new farm.
Existing plant	A plant which is not a new plant.
Farm	An installation as defined in Article 3(3) of Directive 2010/75/EU where pigs or poultry are reared.
Manure	Slurry and/or solid manure.
New farm	A farm first permitted following the publication of these BAT conclusions or a complete replacement of a farm following the publication of these BAT conclusions.
New plant	A plant first permitted at the site of the farm following the publication of these BAT conclusions or a complete replacement of a plant on the existing foundations, following the publication of these BAT conclusions.
Plant	A part of the farm where one of the following processes or activities is carried out: animal housing, manure storage, manure processing. A plant consists of a single building (or facility) and/or the necessary equipment to carry out processes or activities.
Sensitive receptor	Area which need special protection from nuisance, such as: — Residential areas. — Areas where human activities are carried out (e.g. schools, day care centres, recreational areas, hospitals or nursing homes). — Sensitive ecosystems/habitats.
Slurry	Faeces and urine mixed or not with some litter material and some water to give a liquid manure with a dry matter content up to about 10 % that flows under gravity and can be pumped.

([1]) 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).

Term used	Definition
Solid manure	Faeces or droppings and urine mixed or not with litter material that do not flow under gravity and cannot be pumped.
Total ammoniacal nitrogen	Ammonium-N (NH_4-N) and its compounds, including uric acid, which are readily broken down to NH_4-N.
Total nitrogen	Total nitrogen, expressed as N, includes free ammonia and ammonium (NH_4-N), nitrites (NO_2-N), nitrates (NO_3-N) and organic nitrogen compounds.
Total nitrogen excreted	Total nitrogen eliminated from animal metabolic processes through urine and faeces.
Total phosphorus	Total phosphorus, expressed as P_2O_5, includes all inorganic and organic phosphorus compounds, dissolved or bound to particles.
Total phosphorus excreted	Total phosphorus eliminated from animal metabolic processes through urine and faeces.
Waste water	Rainwater run-off commonly mixed with manure, water derived from the cleaning of surfaces (e.g. floors) and equipment, and water derived from the operation of air cleaning systems. This may also be referred to as soiled water.

Definitions for certain animal categories

Term used	Definition
Breeders	Parent stock (males and females) kept to lay eggs for hatching.
Broilers	Chickens reared for meat production.
Broiler breeders	Parent stock (males and females) kept to lay eggs for broilers production.
Farrowing sows	Sows between the perinatal period and the weaning of the piglets.
Fattening pigs	Production pigs typically reared from a live weight of 30 kg to slaughter or first service. This category includes growers, finishers and gilts that have not been serviced.
Gestating sows	Pregnant sows, including gilts.
Laying hens	Grown female chickens for egg production after 16 to 20 weeks of age.
Mating sows	Sows ready for service and before gestation.
Pig	An animal of the porcine species of any age, kept for breeding or fattening.
Piglets	Pigs from birth to weaning.
Poultry	Fowl (chickens), turkeys, guinea fowl, ducks, geese, quails, pigeons, pheasants and partridges reared or kept in captivity for breeding, the production of meat or eggs for consumption, or for restocking supplies of game.

Term used	Definition
Pullets	Young chickens below the age for laying eggs. When reared for egg production a pullet becomes a laying hen when it begins to lay eggs at 16 to 20 weeks of age. When reared for breeding, young female and male chickens are defined as pullets until 20 weeks of age.
Sows	Female pigs during the rearing periods of mating, gestating and farrowing.
Weaners	Young pigs reared from weaning until fattening, typically reared from a live weight of around 8 kg to 30 kg.

GENERAL CONSIDERATIONS

The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection.

Unless otherwise stated, the BAT conclusions are generally applicable.

Unless otherwise stated, emission levels associated with the best available techniques (BAT-AELs) for emissions to air given in these BAT conclusions refer to the mass of substances emitted per animal place, for all rearing cycles carried out during one year (i.e. kg substance/animal place/year).

All values for concentrations expressed as mass of emitted substance per volume in air refer to standard conditions (dry gas at a temperature of 273,15 K, and a pressure of 101,3 kPa).

1. GENERAL BAT CONCLUSIONS

The sector-specific or process-specific BAT conclusions included in Sections 2 and 3 apply in addition to these general BAT conclusions.

1.1. Environmental management systems (EMS)

BAT 1. In order to improve the overall environmental performance of farms, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:

1. commitment of the management, including senior management;
2. definition, by the management, of an environmental policy that includes the continuous improvement of the environmental performance of the installation;
3. planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;
4. implementation of procedures paying particular attention to:
   (a) structure and responsibility;
   (b) training, awareness and competence;
   (c) communication;
   (d) employee involvement;
   (e) documentation;
   (f) effective process control;
   (g) maintenance programmes;
   (h) emergency preparedness and response;
   (i) safeguarding compliance with environmental legislation.

5. checking performance and taking corrective action, paying particular attention to:

   (a) monitoring and measurement (see also the JRC Reference Report on Monitoring of emissions from IED installations — ROM);

   (b) corrective and preventive action;

   (c) maintenance of records;

   (d) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

6. review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;

7. following the development of cleaner technologies;

8. consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;

9. application of sectoral benchmarking (e.g. EMAS Sectoral Reference Document) on a regular basis.

   Specifically for the intensive poultry or pig rearing sector, BAT is also to incorporate the following features in the EMS:

10. implementation of a noise management plan (see BAT 9);

11. implementation of an odour management plan (see BAT 12).

Technical considerations relevant to applicability

The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) is related to the nature, scale and complexity of the farm, and the range of environmental impacts it may have.

1.2. **Good housekeeping**

BAT 2. In order to prevent or reduce the environmental impact and improve overall performance, BAT is to use all the techniques given below.

	Technique	Applicability
a	Proper location of the plant/farm and spatial arrangements of the activities in order to: — reduce transport of animals and materials (including manure); — ensure adequate distances from sensitive receptors requiring protection; — take into account prevailing climatic conditions (e.g. wind and precipitation); — consider the potential future development capacity of the farm; — prevent the contamination of water.	May not be generally applicable to existing plants/farms.
b	Educate and train staff, in particular for: — relevant regulations, livestock farming, animal health and welfare, manure management, worker safety; — manure transport and landspreading; — planning of activities; — emergency planning and management; — repair and maintenance of equipment.	Generally applicable.

	Technique	Applicability
c	Prepare an emergency plan for dealing with unexpected emissions and incidents such as pollution of water bodies. This can include: — a plan of the farm showing the drainage systems and water/effluent sources; — plans of action for responding to certain potential events (e.g. fires, leaking or collapsing of slurry stores, uncontrolled run-off from manure heaps, oil spillages); — available equipment for dealing with a pollution incident (e.g. equipment for plugging land drains, damming ditches, scum boards for oil spillages).	Generally applicable.
d	Regularly check, repair and maintain structures and equipment, such as: — slurry stores for any sign of damage, degradation, leakage; — slurry pumps, mixers, separators, irrigators; — water and feed supply systems; — ventilation system and temperature sensors; — silos and transport equipment (e.g. valves, tubes); — air cleaning systems (e.g. by regular inspections). This can include cleanliness of the farm and pest management.	Generally applicable.
e	Store dead animals in such a way as to prevent or reduce emissions.	Generally applicable.

1.3. **Nutritional management**

BAT 3. In order to reduce total nitrogen excreted and consequently ammonia emissions while meeting the nutritional needs of the animals, BAT is to use a diet formulation and nutritional strategy which includes one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Reduce the crude protein content by using an N-balanced diet based on the energy needs and digestible amino acids.	Generally applicable.
b	Multiphase feeding with a diet formulation adapted to the specific requirements of the production period.	Generally applicable.
c	Addition of controlled amounts of essential amino acids to a low crude protein diet.	Applicability may be restricted when low-protein feedstuffs are not economically available. Synthetic amino acids are not applicable to organic livestock production.

	Technique [1]	Applicability
d	Use of authorised feed additives which reduce the total nitrogen excreted.	Generally applicable.

[1] A description of the techniques is given in Section 4.10.1. Information on the effectiveness of the techniques for ammonia emission reduction can be taken from recognised European or international guidance e.g. UNECE guidance document on 'Options for ammonia mitigation'.

Table 1.1

BAT-associated total nitrogen excreted

Parameter	Animal category	BAT-associated total nitrogen excreted [1] [2] (kg N excreted/animal place/year)
Total nitrogen excreted, expressed as N.	Weaners	1,5-4,0
	Fattening pigs	7,0-13,0
	Sows (including piglets)	17,0-30,0
	Laying hens	0,4-0,8
	Broilers	0,2-0,6
	Ducks	0,4-0,8
	Turkeys	1,0-2,3 [3]

[1] The lower end of the range can be achieved by using a combination of techniques.
[2] The BAT-associated total nitrogen excreted is not applicable to pullets or breeders, for all poultry species.
[3] The upper end of the range is associated with the rearing of male turkeys.

The associated monitoring is in BAT 24. The BAT-associated total nitrogen excreted levels may not be applicable to organic livestock production and to the rearing of poultry species not indicated above.

BAT 4. In order to reduce the total phosphorus excreted, while meeting the nutritional needs of the animals, BAT is to use a diet formulation and a nutritional strategy which includes one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Multiphase feeding with a diet formulation adapted to the specific requirements of the production period.	Generally applicable.
b	Use of authorised feed additives which reduce the total phosphorus excreted (e.g. phytase).	Phytase may not be applicable in case of organic livestock production.
c	Use of highly digestible inorganic phosphates for the partial replacement of conventional sources of phosphorus in the feed.	Generally applicable within the constraints associated with the availability of highly digestible inorganic phosphates.

[1] A description of the techniques is given in Section 4.10.2.

Table 1.2

BAT-associated total phosphorus excreted

Parameter	Animal category	BAT-associated total phosphorus excreted [1] [2] (kg P_2O_5 excreted/animal place/year)
Total phosphorus excreted, expressed as P_2O_5.	Weaners	1,2-2,2
	Fattening pigs	3,5-5,4
	Sows (including piglets)	9,0-15,0
	Laying hens	0,10-0,45
	Broilers	0,05-0,25
	Turkeys	0,15-1,0

(1) The lower end of the range can be achieved by using a combination of techniques.
(2) The BAT-associated total phosphorus excreted is not applicable to pullets or breeders, for all poultry species.

The associated monitoring is in BAT 24. The BAT-associated total phosphorus excreted levels may not be applicable to organic livestock production and to the rearing of poultry species not indicated above.

1.4. **Efficient use of water**

BAT 5. In order to use water efficiently, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Keep a record of water use.	Generally applicable.
b	Detect and repair water leakages.	Generally applicable.
c	Use high-pressure cleaners for cleaning animal housing and equipment.	Not applicable to poultry plants using dry cleaning systems.
d	Select and use suitable equipment (e.g. nipple drinkers, round drinkers, water troughs) for the specific animal category while ensuring water availability (*ad libitum*).	Generally applicable.
e	Verify and (if necessary) adjust on a regular basis the calibration of the drinking water equipment.	Generally applicable.
f	Reuse uncontaminated rainwater as cleaning water.	May not be applicable to existing farms, due to high costs. Applicability may be restricted by biosecurity risks.

1.5. Emissions from waste water

BAT 6. In order to reduce the generation of waste water, BAT is to use a combination of the techniques given below.

	Technique [1]	Applicability
a	Keep the fouled yard areas as small as possible.	Generally applicable.
b	Minimise use of water.	Generally applicable.
c	Segregate uncontaminated rainwater from waste water streams that require treatment.	May not be applicable to existing farms.

(1) A description of the technique is given in Section 4.1.

BAT 7. In order to reduce emissions to water from waste water, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Drain waste water to a dedicated container or to a slurry store.	Generally applicable.
b	Treat waste water.	Generally applicable.
c	Landspreading of waste water e.g. by using an irrigation system such as sprinkler, travelling irrigator, tanker, umbilical injector.	Applicability may be restricted due to the limited availability of suitable land adjacent to the farm. Applicable only for waste water with a proven low level of contamination.

(1) A description of the techniques is given in Section 4.1.

1.6. Efficient use of energy

BAT 8. In order to use energy efficiently in a farm, BAT is to use a combination of the techniques given below.

	Technique [1]	Applicability
a	High efficiency heating/cooling and ventilation systems.	May not be applicable to existing plants.
b	Optimisation of heating/cooling and ventilation systems and management, especially where air cleaning systems are used.	Generally applicable.
c	Insulation of the walls, floors and/or ceilings of animal housing.	May not be applicable to plants using natural ventilation. Insulation may not be applicable to existing plants due to structural restrictions.
d	Use of energy-efficient lighting.	Generally applicable.

	Technique [1]	Applicability
e	Use of heat exchangers. One of the following systems may be used: 1. air-air; 2. air-water; 3. air-ground.	Air-ground heat exchangers are only applicable when there is available space due to the need for a large soil surface.
f	Use of heat pumps for heat recovery.	The applicability of heat pumps based on geothermal heat recovery is limited when using horizontal pipes due to the need for space availability.
g	Heat recovery with heated and cooled littered floor (combideck system).	Not applicable to pig plants. Applicability depends on the possibility to install closed underground storage for the circulating water.
h	Apply natural ventilation.	Not applicable to plants with a centralised ventilation system. In pig plants, this may not be applicable to: — housing systems with littered floors in warm climates; — housing systems without littered floors or without covered, insulated boxes (e.g. kennels) in cold climates. In poultry plants, this may not be applicable: — during the initial stage of rearing, apart from duck production; — due to extreme climate conditions.

(1) A description of the techniques is given in Section 4.2.

1.7. Noise emissions

BAT 9. In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to set up and implement a noise management plan, as part of the environmental management system (see BAT 1), that includes the following elements:

i. a protocol containing appropriate actions and timelines;

ii. a protocol for conducting noise monitoring;

iii. a protocol for response to identified noise events;

iv. a noise reduction programme designed to e.g. identify the source(s), to monitor noise emissions, to characterise the contributions of the sources and to implement elimination and/or reduction measures;

v. a review of historical noise incidents and remedies and the dissemination of noise incident knowledge.

Applicability

BAT 9 is only applicable to cases where a noise nuisance at sensitive receptors is expected and/or has been substantiated.

BAT 10. In order to prevent, or where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a	Ensure adequate distances between the plant/farm and the sensitive receptors.	At the planning stage of the plant/farm, adequate distances between the plant/farm and the sensitive receptors are ensured by applying minimum standard distances.	May not be generally applicable to existing plants/farms.
b	Equipment location.	Noise levels can be reduced by: i. increasing the distance between the emitter and the receiver (by locating equipment as far away as practicable from sensitive receptors); ii. minimising the length of feed delivery pipes; iii. Locating feed bins and feed silos so as to minimise the movement of vehicles on the farm.	In the case of existing plants, the relocation of equipment may be restricted by the lack of space or excessive costs.
c	Operational measures.	These include measures, such as: i. closure of doors and major openings of the building, especially during feeding time, if possible; ii. equipment operation by experienced staff; iii. avoidance of noisy activities at night and during weekends, if possible; iv. provisions for noise control during maintenance activities; v. operate conveyers and augers full of feed, if possible; vi. keep outdoor scraped areas to a minimum in order to reduce noise from scraper tractors.	Generally applicable.
d	Low-noise equipment.	This includes equipment, such as: i. high efficiency fans, when natural ventilation is not possible or sufficient; ii. pumps and compressors; iii. feeding system which reduces the pre-feeding stimulus (e.g. holding hoppers, passive ad libitum feeders, compact feeders).	BAT 7.d.iii is only applicable to pig plants. Passive *ad libitum* feeders are only applicable when the equipment is new or replaced or when animals do not require a restricted feeding.

	Technique	Description	Applicability
e	Noise-control equipment.	This includes: i. noise reducers; ii. vibration isolation; iii. enclosure of noisy equipment (e.g. mills, pneumatic conveyers); iv. soundproofing of buildings.	Applicability may be restricted due to space requirements, and health and safety issues. Not applicable to noise-absorbent materials impeding the effective cleaning of the plant.
f	Noise abatement.	Noise propagation can be reduced by inserting obstacles between emitters and receivers.	May not be generally applicable due to biosecurity reasons.

1.8. **Dust emissions**

BAT 11. In order to reduce dust emissions from each animal house, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Reduce dust generation inside livestock buildings. For this purpose, a combination of the following techniques may be used:	
1.	1. Use coarser litter material (e.g. long straw or wood shavings rather than chopped straw);	Long straw is not applicable to slurry-based systems.
	2. Apply fresh litter using a low-dust littering technique (e.g. by hand);	Generally applicable.
	3. Apply *ad libitum* feeding;	Generally applicable.
	4. Use moist feed, pelleted feed or add oily raw materials or binders in dry feed systems;	Generally applicable.
	5. Equip dry feed stores which are filled pneumatically with dust separators;	Generally applicable.
	6. Design and operate the ventilation system with low air speed within the house.	Applicability may be limited by animal welfare considerations.
b	Reduce dust concentration inside housing by applying one of the following techniques:	
	1. Water fogging;	Applicability may be restricted by the animal sensation of thermal decrease during fogging, in particular at sensitive stages of the animal's life, and/or for cold and humid climates. Applicability may be also restricted for solid manure systems at the end of the rearing period due to high ammonia emissions.

	Technique (1)	Applicability
	2. Oil spraying;	Only applicable to poultry plants with birds older than around 21 days. The applicability to plants for laying hens may be limited due to the risk of contamination of the equipment present in the shed.
	3. Ionisation.	May not be applicable to pig plants or to existing poultry plants due to technical and/or economic reasons.
c	Treatment of exhaust air by an air cleaning system, such as:	
	1. Water trap;	Only applicable to plants with a tunnel ventilation system.
	2. Dry filter;	Only applicable to poultry plants with a tunnel ventilation system.
	3. Water scrubber;	This technique may not be generally applicable due to the high implementation cost. Applicable to existing plants only where a centralised ventilation system is used.
	4. Wet acid scrubber;	
	5. Bioscrubber (or biotrickling filter);	
	6. Two-stage or three-stage air cleaning system;	
	7. Biofilter.	Only applicable to slurry-based plants. A sufficient area outside the animal house is needed to accommodate the filter packages. This technique may not be generally applicable due to the high implementation cost. Applicable to existing plants only where a centralised ventilation system is used.

(1) A description of the techniques is given in Sections 4.3 and 4.11.

1.9. **Odour emissions**

BAT 12. In order to prevent, or where that is not practicable, to reduce odour emissions from a farm, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes the following elements:

i. a protocol containing appropriate actions and timelines;

ii. a protocol for conducting odour monitoring;

iii. a protocol for response to identified odour nuisance;

iv. an odour prevention and elimination programme designed to e.g. identify the source(s), to monitor odour emissions (see BAT 26), to characterise the contributions of the sources and to implement elimination and/or reduction measures;

v. a review of historical odour incidents and remedies and the dissemination of odour incident knowledge.

The associated monitoring is in BAT 26.

Applicability

BAT 12 is only applicable to cases where an odour nuisance at sensitive receptors is expected and/or has been substantiated.

BAT 13. In order to prevent or, where that is not practicable, to reduce odour emissions and/or odour impact from a farm, BAT is to use a combination of the techniques given below.

	Technique [1]	Applicability
a	Ensure adequate distances between the farm/plant and the sensitive receptors.	May not be generally applicable to existing farms/plants.
b	Use a housing system which implements one or a combination of the following principles: — keeping the animals and the surfaces dry and clean (e.g. avoid feed spillages, avoid dung in lying areas of partly slatted floors); — reducing the emitting surface of manure (e.g. use metal or plastic slats, channels with a reduced exposed manure surface); — removing manure frequently to an external (covered) manure store; — reducing the temperature of the manure (e.g. by slurry cooling) and of the indoor environment; — decreasing the air flow and velocity over the manure surface; — keeping the litter dry and under aerobic conditions in litter-based systems.	Decreasing the temperature of the indoor environment, the air flow and the velocity may not be applicable due to animal welfare considerations. Slurry removal by flushing is not applicable to pig farms located close to sensitive receptors due to odour peaks. See applicability for animal housing in BAT 30, BAT 31, BAT 32, BAT 33 and BAT 34.
c	Optimise the discharge conditions of exhaust air from the animal house by using one or a combination of the following techniques: — increasing the outlet height (e.g. exhaust air above roof level, stacks, divert air exhaust through the ridge instead of through the low part of the walls); — increasing the vertical outlet ventilation velocity; — effective placement of external barriers to create turbulence in the outgoing air flow (e.g. vegetation); — adding deflector covers in exhaust apertures located in low parts of walls in order to divert exhaust air towards the ground; — dispersing the exhaust air at the housing side which faces away from the sensitive receptor; — aligning the ridge axis of a naturally ventilated building transversally to the prevailing wind direction.	Alignment of the ridge axis is not applicable to existing plants.

	Technique [1]	Applicability
d	Use an air cleaning system, such as: 1. Bioscrubber (or biotrickling filter); 2. Biofilter; 3. Two-stage or three-stage air cleaning system.	This technique may not be generally applicable due to the high implementation cost. Applicable to existing plants only where a centralised ventilation system is used. A biofilter is only applicable to slurry-based plants. For a biofilter, a sufficient area outside the animal house is needed to accommodate the filter packages.
e	Use one or a combination of the following techniques for storage of manure:	
	1. Cover slurry or solid manure during storage;	See applicability of BAT 16.b for slurry. See applicability of BAT 14.b for solid manure.
	2. Locate the store taking into account the general wind direction and/or adopt measures to reduce wind speed around and above the store (e.g. trees, natural barriers);	Generally applicable.
	3. Minimise stirring of slurry.	Generally applicable.
f	Process manure with one of the following techniques in order to minimise odour emissions during (or prior to) landspreading:	
	1. Aerobic digestion (aeration) of slurry;	See applicability of BAT 19.d.
	2. Compost solid manure;	See applicability of BAT 19.f.
	3. Anaerobic digestion.	See applicability of BAT 19.b.
g	Use one or a combination of the following techniques for manure landspreading:	
	1. Band spreader, shallow injector or deep injector for slurry landspreading;	See applicability of BAT 21.b, BAT 21.c or BAT 21.d.
	2. Incorporate manure as soon as possible.	See applicability of BAT 22.

(1) A description of the techniques is given in Sections 4.4 and 4.11.

1.10. Emissions from solid manure storage

BAT 14. In order to reduce ammonia emissions to air from the storage of solid manure, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Reduce the ratio between the emitting surface area and the volume of the solid manure heap.	Generally applicable.
b	Cover solid manure heaps.	Generally applicable when solid manure is dried or pre-dried in animal housing. May not be applicable to not dried solid manure in case of frequent addition to the heap.
c	Store dried solid manure in a barn.	Generally applicable.

[1] A description of the techniques is given in Section 4.5.

BAT 15. In order to prevent, or where that is not practicable, to reduce emissions to soil and water from the storage of solid manure, BAT is to use a combination of the techniques given below in the following order of priority.

	Technique [1]	Applicability
a	Store dried solid manure in a barn.	Generally applicable
b	Use a concrete silo for storage of solid manure.	Generally applicable.
c	Store solid manure on solid impermeable floor equipped with a drainage system and a collection tank for the run-off.	Generally applicable.
d	Select a storage facility with a sufficient capacity to hold the solid manure during periods in which landspreading is not possible.	Generally applicable.
e	Store solid manure in field heaps placed away from surface and/or underground watercourses which liquid run-off might enter.	Only applicable to temporary field heaps which change location each year.

[1] A description of the techniques is given in Section 4.5.

1.11. Emissions from slurry storage

BAT 16. In order to reduce ammonia emissions to air from a slurry store, BAT is to use a combination of the techniques given below.

	Technique [1]	Applicability
a	Appropriate design and management of the slurry store by using a combination of the following techniques:	

	Technique [1]	Applicability
	1. Reduce the ratio between the emitting surface area and the volume of the slurry store;	May not be generally applicable to existing stores. Excessively high slurry stores may not be applicable due to increased costs and safety risks.
	2. Reduce wind velocity and air exchange on the slurry surface by operating the store at a lower level of fill;	May not be generally applicable to existing stores.
	3. Minimise stirring of slurry.	Generally applicable.
b	Cover the slurry store. For this purpose, one of the following techniques may be used:	
	1. Rigid cover;	May not be applicable to existing plants due to economic considerations and structural limitations to withstand the extra load.
	2. Flexible covers;	Flexible covers are not applicable to areas where prevailing weather conditions can compromise their structure.
	3. Floating covers such as: — plastic pellets; — light bulk materials; — floating flexible covers; — geometrical plastic tiles; — air-inflated cover; — natural crust; — straw.	The use of plastic pellets, light bulk materials and geometrical plastic tiles is not applicable to naturally crusting slurries. Agitation of the slurry during stirring, filling and emptying may preclude the use of some floating materials which may cause sedimentation or blockages in the pumps. Natural crust formation may not be applicable to cold climates and/or to slurry with low dry matter content. Natural crust is not applicable to stores where stirring, filling and/or discharging of slurry renders the natural crust unstable.
c	Slurry acidification.	Generally applicable.

(1) A description of the techniques is given in Sections 4.6.1 and 4.12.3.

BAT 17. In order to reduce ammonia emissions to air from an earth-banked slurry store (lagoon), BAT is to use a combination of the techniques given below.

	Technique [1]	Applicability
a	Minimise stirring of the slurry.	Generally applicable.

	Technique [1]	Applicability
b	Cover the earth-banked slurry store (lagoon) with a flexible and/or floating cover such as: — flexible plastic sheets; — light bulk materials; — natural crust; — straw.	Plastic sheets may not be applicable to large existing lagoons due to structural reasons. Straw and light bulk materials may not be applicable to large lagoons where wind drift does not permit the lagoon surface to be kept fully covered. The use of light bulk materials is not applicable to naturally crusting slurries. Agitation of the slurry during stirring, filling and emptying may preclude the use of some floating materials which may cause sedimentation or blockages in the pumps. Natural crust formation may not be applicable to cold climates and/or to slurry with low dry matter content. Natural crust is not applicable to lagoons where stirring, filling and/or discharging of slurry renders the natural crust unstable.

(1) A description of the techniques is given in Section 4.6.1.

BAT 18. In order to prevent emissions to soil and water from slurry collection, piping, and from a store and/or an earth-banked storage (lagoon), BAT is to use a combination of the techniques given below.

	Technique [1]	Applicability
a	Use stores that are able to withstand mechanical, chemical and thermal influences.	Generally applicable.
b	Select a storage facility with a sufficient capacity to hold the slurry during periods in which landspreading is not possible.	Generally applicable.
c	Construct leak-proof facilities and equipment for collection and transfer of slurry (e.g. pits, channels, drains, pump stations).	Generally applicable.
d	Store slurry in earth-banked stores (lagoons) with an impermeable base and walls e.g. with clay or plastic lining (or double-lined).	Generally applicable to lagoons.
e	Install a leakage detection system, e.g. consisting of a geomembrane, a drainage layer and a drainage pipe system.	Only applicable to new plants.
f	Check structural integrity of stores at least once every year.	Generally applicable.

(1) A description of the techniques is given in Section 3.1.1 and 4.6.2.

1.12. On farm processing of manure

BAT 19. If on-farm processing of manure is used, in order to reduce emissions of nitrogen, phosphorus, odour and microbial pathogens to air and water and facilitate manure storage and/or landspreading, BAT is to process the manure by applying one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Mechanical separation of slurry. This includes e.g.: Screw press separator; — Decanter-centrifuge separator; — Coagulation-Flocculation; — Separation by sieves; — Filter pressing.	Only applicable when: — a reduction of nitrogen and phosphorus content is needed due to limited available land for manure application; — manure cannot be transported for landspreading at a reasonable cost. The use of polyacrylamide as a flocculant may not be applicable due to the risk of acrylamide formation.
b	Anaerobic digestion of manure in a biogas installation.	This technique may not be generally applicable due to the high implementation cost.
c	Use of an external tunnel for manure drying.	Only applicable to manure from plants for laying hens. Not applicable to existing plants without manure belts.
d	Aerobic digestion (aeration) of slurry.	Only applicable when pathogen and odour reduction is important prior to landspreading. In cold climates, it may be difficult to maintain the required level of aeration during winter.
e	Nitrification-denitrification of slurry.	Not applicable to new plants/farms. Only applicable to existing plants/farms when the removal of nitrogen is necessary due to limited available land for manure application.
f	Composting of solid manure.	Only applicable when: — manure cannot be transported for landspreading at a reasonable cost; — pathogen and odour reduction is important prior to landspreading; — there is enough space in the farm for windrows to be established.

[1] A description of the techniques is given in Section 4.7.

1.13. Manure landspreading

BAT 20. In order to prevent or, where that is not practicable, to reduce emissions of nitrogen, phosphorus and microbial pathogens to soil and water from manure landspreading, BAT is to use all the techniques given below.

	Technique
a	Assess the manure receiving land to identify risks of run-off, taking into account: — soil type, conditions and slope of the field; — climatic conditions; — field drainage and irrigation; — crop rotations; — water resources and water protected zones.

	Technique
b	Keep sufficient distance between manure spreading fields (leaving an untreated strip of land) and: 1. areas where there is a risk of run-off to water such as watercourses, springs, boreholes, etc.; 2. neighbouring properties (including hedges).
c	Avoid manure spreading when the risk of run-off can be significant. In particular, manure is not applied when: 1. the field is flooded, frozen or snow-covered; 2. soil conditions (e.g. water saturation or compaction) in combination with the slope of the field and/or field drainage are such that the risk of run-off or drainage is high; 3. run-off can be anticipated according to expected rainfall events.
d	Adapt the manure landspreading rate taking into account the nitrogen and phosphorus content of the manure and taking into account the characteristics of the soil (e.g. nutrient content), the seasonal crop requirements and weather or field conditions that could cause run-off.
e	Synchronize manure landspreading with the nutrient demand of crops.
f	Check the spreading fields at regular intervals to identify any sign of run-off and properly respond when necessary.
g	Ensure adequate access to the manure store and that loading of manure can be done effectively without spillage.
h	Check that machinery for manure landspreading is in good working order and set at the proper application rate.

BAT 21. In order to reduce ammonia emissions to air from slurry landspreading, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Slurry dilution, followed by techniques such as low-pressure water irrigation system.	Not applicable to crops grown to be eaten raw due to the risk of contamination. Not applicable when the soil type does not allow rapid infiltration of dilute slurry into the soil. Not applicable when crops do not require irrigation. Applicable to fields easily connected to the farm by pipework.
b	Band spreader, by applying one of the following techniques: 1. Trailing hose; 2. Trailing shoe.	Applicability may be limited when the straw content of the slurry is too high or when the dry matter content of the slurry is higher than 10 %. Trailing shoe is not applicable to growing solid-seeded arable crops.

	Technique [1]	Applicability
c	Shallow injector (open slot).	Not applicable on stony, shallow or compacted soil where it is difficult to achieve a uniform penetration. Applicability may be limited where crops may be damaged by machinery.
d	Deep injector (closed slot).	Not applicable on stony, shallow or compacted soil where it is difficult to achieve a uniform penetration and an effective slit closure. Not applicable during the vegetation of the crops. Not applicable on grassland, unless changing to arable land or when reseeding.
e	Slurry acidification.	Generally applicable.

[1] A description of the techniques is given in Sections 4.8.1 and 4.12.3.

BAT 22. In order to reduce ammonia emissions to air from manure landspreading, BAT is to incorporate the manure into the soil as soon as possible.

Description

Incorporation of manure spread on the soil surface is done by either ploughing or using other cultivation equipment, such as tines or disc harrows, depending on the soil type and conditions. Manure is completely mixed with soil or buried.

Solid manure spreading is carried out by a suitable spreader (e.g. rota-spreader, rear discharge spreader, dual-purpose spreader). Slurry landspreading is carried out according to BAT 21.

Applicability

Not applicable to grassland and conservation tillage, unless changing to arable land or when reseeding. Not applicable to cultivated land with crops that can be damaged by the incorporation of manure. Incorporation of slurry is not applicable after landspreading using shallow or deep injectors.

Table 1.3

BAT-associated time delay between manure landspreading and incorporation into the soil

Parameter	BAT-associated time delay between manure landspreading and incorporation into the soil (hours)
Time	0 [1]-4 [2]

[1] The lower end of the range corresponds to immediate incorporation.
[2] The upper end of the range can be up to 12 hours when conditions are not favourable for a faster incorporation, e.g. when human and machinery resources are not economically available.

1.14. Emissions from the whole production process

BAT 23. In order to reduce ammonia emissions from the whole production process for the rearing of pigs (including sows) or poultry, BAT is to estimate or calculate the reduction of ammonia emissions from the whole production process using the BAT implemented on the farm.

1.15. **Monitoring of emissions and process parameters**

BAT 24. BAT is to monitor the total nitrogen and total phosphorus excreted in manure using one of the following techniques with at least the frequency given below.

	Technique (1)	Frequency	Applicability
a	Calculation by using a mass balance of nitrogen and phosphorus based on the feed intake, crude protein content of the diet, total phosphorus and animal performance.	Once every year for each animal category.	Generally applicable.
b	Estimation by using manure analysis for total nitrogen and total phosphorus content.		

(1) A description of the techniques is given in Section 4.9.1.

BAT 25. BAT is to monitor ammonia emissions to air using one of the following techniques with at least the frequency given below.

	Technique (1)	Frequency	Applicability
a	Estimation by using a mass balance based on the excretion and the total (or total ammoniacal) nitrogen present at each manure management stage.	Once every year for each animal category.	Generally applicable.
b	Calculation by measuring the ammonia concentration and the ventilation rate using ISO, national or international standard methods or other methods ensuring data of an equivalent scientific quality.	Every time there are significant changes to at least one of the following parameters: (a) the type of livestock reared at the farm; (b) the housing system.	Only applicable to emissions from each animal house. Not applicable to plants with an air cleaning system installed. In this case, BAT 28 applies. Due to the cost of measurements, this technique may not be generally applicable.
c	Estimation by using emission factors.	Once every year for each animal category.	Generally applicable.

(1) A description of the techniques is given in Section 4.9.2.

BAT 26. BAT is to periodically monitor odour emissions to air.

Description

Odour emissions can be monitored by using:

— EN standards (e.g. by using dynamic olfactometry according to EN 13725 in order to determine odour concentration).

— When applying alternative methods for which no EN standards are available (e.g. measurement/estimation of odour exposure, estimation of odour impact), ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality can be used.

Applicability

BAT 26 is only applicable to cases where an odour nuisance at sensitive receptors is expected and/or has been substantiated.

BAT 27. BAT is to monitor dust emissions from each animal house using one of the following techniques with at least the frequency given below.

	Technique [1]	Frequency	Applicability
a	Calculation by measuring the dust concentration and the ventilation rate using EN standard methods or other methods (ISO, national or international) ensuring data of an equivalent scientific quality.	Once every year.	Only applicable to dust emissions from each animal house. Not applicable to plants with an air cleaning system installed. In this case, BAT 28 applies. Due to the cost of measurements, this technique may not be generally applicable.
b	Estimation by using emission factors.	Once every year.	Due to the cost of establishing emissions factors, this technique may not be generally applicable.

[1] A description of the techniques is given in Sections 4.9.1 and 4.9.2.

BAT 28. BAT is to monitor ammonia, dust and/or odour emissions from each animal house equipped with an air cleaning system by using all of the following techniques with at least the frequency given below.

	Technique [1]	Frequency	Applicability
a	Verification of the air cleaning system performance by measuring ammonia, odour and/or dust under practical farm conditions and according to a prescribed measurement protocol and using EN standard methods or other methods (ISO, national or international) ensuring data of an equivalent scientific quality.	Once	Not applicable if the air cleaning system has been verified in combination with a similar housing system and operating conditions.
b	Control of the effective function of the air cleaning system (e.g. by continuously recording operational parameters or using alarm systems).	Daily	Generally applicable.

[1] A description of the techniques is given in Section 4.9.3.

BAT 29. BAT is to monitor the following process parameters at least once every year.

	Parameter	Description	Applicability
a	Water consumption.	Recording using e.g. suitable meters or invoices. The main water-consuming processes in animal houses (cleaning, feeding, etc.) can be monitored separately.	Monitoring the main water-consuming processes separately may not be applicable to existing farms, depending on the configuration of the water supply network.

	Parameter	Description	Applicability
b	Electric energy consumption.	Recording using e.g. suitable meters or invoices. Electricity consumption of animal houses is monitored separately from other plants in the farm. The main energy-consuming processes in animal houses (heating, ventilation, lighting, etc.) can be monitored separately.	Monitoring the main energy-consuming processes separately may not be applicable to existing farms, depending on the configuration of the energy supply network.
c	Fuel consumption.	Recording using e.g. suitable meters or invoices.	Generally applicable.
d	Number of incoming and outgoing animals, including births and deaths when relevant.	Recording using e.g. existing registers.	
e	Feed consumption.	Recording using e.g. invoices or existing registers.	
f	Manure generation.	Recording using e.g. existing registers.	

2. BAT CONCLUSIONS FOR THE INTENSIVE REARING OF PIGS

2.1. Ammonia emissions from pig houses

BAT 30. In order to reduce ammonia emissions to air from each pig house, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Animal category	Applicability
a	One of the following techniques, which apply one or a combination of the following principles: (i) reduce the ammonia emitting surface; (ii) increase the frequency of slurry (manure) removal to external storage; (iii) separate urine from faeces; (iv) keep litter clean and dry..		
	0. A deep pit (in case of a fully or partly slatted floor) only if used in combination with an additional mitigation measure, e.g.: — a combination of nutritional management techniques; — air cleaning system; — pH reduction of the slurry; — slurry cooling.	All pigs	Not applicable to new plants, unless a deep pit is combined with an air cleaning system, slurry cooling and/or pH reduction of the slurry.

Technique [1]	Animal category	Applicability
1. A vacuum system for frequent slurry removal (in case of a fully or partly slatted floor).	All pigs	May not be generally applicable to existing plants due to technical and/or economic considerations.
2. Slanted walls in the manure channel (in case of a fully or partly slatted floor).	All pigs	
3. A scraper for frequent slurry removal (in case of a fully or partly slatted floor).	All pigs	
4. Frequent slurry removal by flushing (in case of a fully or partly slatted floor).	All pigs	May not be generally applicable to existing plants due to technical and/or economic considerations. When the liquid fraction of the slurry is used for flushing, this technique may not be applicable to farms located close to sensitive receptors due to odour peaks during flushing.
5. Reduced manure pit (in case of a partly slatted floor).	Mating and gestating sows	May not be generally applicable to existing plants due to technical and/or economic considerations.
	Fattening pigs	
6. Full litter system (in case of a solid concrete floor).	Mating and gestating sows	Solid manure systems are not applicable to new plants unless it can be justified for animal welfare reasons. May not be applicable to naturally ventilated plants located in warm climates and to existing plants with forced ventilation for weaners and fattening pigs. BAT 30.a7 may require large space availability.
	Weaners	
	Fattening pigs	
7. Kennel/hut housing (in case of a partly slatted floor).	Mating and gestating sows	
	Weaners	
	Fattening pigs	
8. Straw flow system (in case of a solid concrete floor).	Weaners	
	Fattening pigs	
9. Convex floor and separated manure and water channels (in case of partly slatted pens).	Weaners	May not be generally applicable to existing plants due to technical and/or economic considerations.
	Fattening pigs	

	Technique (1)	Animal category	Applicability
	10. Littered pens with combined manure generation (slurry and solid manure).	Farrowing sows	Not applicable to existing plants without solid concrete floors.
	11. Feeding/lying boxes on solid floor (in case of litter-based pens).	Mating and gestating sows	
	12. Manure pan (in case of a fully or partly slatted floor).	Farrowing sows	Generally applicable.
	13. Manure collection in water.	Weaners	May not be generally applicable to existing plants due to technical and/or economic considerations.
		Fattening pigs	
	14. V-shaped manure belts (in case of partly slatted floor).	Fattening pigs	
	15. A combination of water and manure channels (in case of a fully slatted floor).	Farrowing sows	
	16. Littered external alley (in case of a solid concrete floor).	Fattening pigs	Not applicable to cold climates. May not be generally applicable to existing plants due to technical and/or economic considerations.
b	Slurry cooling.	All pigs	Not applicable when: — heat reuse is not possible; — litter is used.
c	Use of an air cleaning system, such as: 1. Wet acid scrubber; 2. Two-stage or three-stage air cleaning system; 3. Bioscrubber (or biotrickling filter).	All pigs	May not be generally applicable due to the high implementation cost. Applicable to existing plants only where a centralised ventilation system is used.
d	Slurry acidification.	All pigs	Generally applicable.
e	Use of floating balls in the manure channel.	Fattening pigs	Not applicable to plants equipped with pits that have slanted walls and to plants that apply slurry removal by flushing.

(1) A description of the techniques is given in Sections 4.11 and 4.12.

Table 2.1

BAT-AEL for ammonia emissions to air from each pig house

Parameter	Animal category	BAT-AEL (1) (kg NH_3/animal place/year)
Ammonia expressed as NH_3	Mating and gestating sows	0,2-2,7 (2) (3)
	Farrowing sows (including piglets) in crates	0,4-5,6 (4)
	Weaners	0,03-0,53 (5) (6)
	Fattening pigs	0,1-2,6 (7) (8)

(1) The lower end of the range is associated with the use of an air cleaning system.
(2) For existing plants using a deep pit in combination with nutritional management techniques, the upper end of the BAT-AEL is 4,0 kg NH_3/animal place/year.
(3) For plants using BAT 30.a6, 30.a7 or 30.a11, the upper end of the BAT-AEL is 5,2 kg NH_3/animal place/year.
(4) For existing plants using BAT 30.a0 in combination with nutritional management techniques, the upper end of the BAT-AEL is 7,5 kg NH_3/animal place/year.
(5) For existing plants using a deep pit in combination with nutritional management techniques, the upper end of the BAT-AEL is 0,7 kg NH_3/animal place/year.
(6) For plants using BAT 30.a6, 30.a7 or 30.a8, the upper end of the BAT-AEL is 0,7 kg NH_3/animal place/year.
(7) For existing plants using a deep pit in combination with nutritional management techniques, the upper end of the BAT-AEL is 3,6 kg NH_3/animal place/year.
(8) For plants using BAT 30.a6, 30.a7, 30.a8 or 30.a16, the upper end of the BAT-AEL is 5,65 kg NH_3/animal place/year.

The BAT-AELs may not be applicable to organic livestock production. The associated monitoring is in BAT 25.

3. BAT CONCLUSIONS FOR THE INTENSIVE REARING OF POULTRY

3.1. Ammonia emissions from poultry houses

3.1.1. Ammonia emissions from houses for laying hens, broiler breeders or pullets

BAT 31. In order to reduce ammonia emissions to air from each house for laying hens, broiler breeders or pullets, BAT is to use one or a combination of the techniques given below.

	Technique (1)	Applicability
a	Manure removal by belts (in case of enriched or unenriched cage systems) with at least: — one removal per week with air drying; or — two removals per week without air drying.	Enriched cage systems are not applicable to pullets and broiler breeders. Unenriched cage systems are not applicable to laying hens.
b	In case of non-cage systems:	
	0. Forced ventilation system and infrequent manure removal (in case of deep litter with a manure pit) only if used in combination with an additional mitigation measure, e.g.: — achieving a high dry matter content of the manure; — an air cleaning system.	Not applicable to new plants, unless combined with an air cleaning system.

	Technique [1]	Applicability
	1. Manure belt or scraper (in case of deep litter with a manure pit).	Applicability to existing plants may be limited by the requirement for a complete revision of the housing system.
	2. Forced air drying of manure via tubes (in case of deep litter with a manure pit)	The technique can be applied only to plants with sufficient space underneath the slats.
	3. Forced air drying of manure using perforated floor (in case of deep litter with a manure pit).	Due to high implementation costs, applicability to existing plants may be limited.
	4. Manure belts (in case of aviary).	Applicability to existing plants depends on the width of the shed.
	5. Forced drying of litter using indoor air (in case of solid floor with deep litter).	Generally applicable.
c	Use of an air cleaning system, such as: 1. Wet acid scrubber; 2. Two-stage or three-stage air cleaning system; 3. Bioscrubber (or biotrickling filter).	May not be generally applicable due to the high implementation cost. Applicable to existing plants only where a centralised ventilation system is used.

[1] A description of the techniques is given in Sections 4.11 and 4.13.1.

Table 3.1

BAT-AELs for ammonia emissions to air from each house for laying hens

Parameter	Type of housing	BAT-AEL (kg NH_3/animal place/year)
Ammonia expressed as NH_3	Cage system	0,02-0,08
	Non-cage system	0,02-0,13 [1]

[1] For existing plants using a forced ventilation system and an infrequent manure removal (in case of deep litter with a manure pit), in combination with a measure achieving a high dry matter content of the manure, the upper end of the BAT-AEL is 0,25 kg NH_3/animal place/year.

The associated monitoring is in BAT 25. The BAT-AEL may not be applicable to organic livestock production.

3.1.2. Ammonia emissions from houses for broilers

BAT 32. In order to reduce ammonia emissions to air from each house for broilers, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Forced ventilation and a non-leaking drinking system (in case of solid floor with deep litter).	Generally applicable.

	Technique [1]	Applicability
b	Forced drying system of litter using indoor air (in case of solid floor with deep litter).	For existing plants, the applicability of forced air drying systems depends on the height of the ceiling. Forced air drying systems may not be applicable to warm climates, depending on the indoor temperature.
c	Natural ventilation, equipped with a non-leaking drinking system (in case of solid floor with deep litter).	Natural ventilation is not applicable to plants with a centralised ventilation system. Natural ventilation may not be applicable during the initial stage of rearing of broilers and due to extreme climate conditions.
d	Litter on manure belt and forced air drying (in case of tiered floor systems).	For existing plants, the applicability depends on the height of the side walls.
e	Heated and cooled littered floor (in case of combideck systems).	For existing plants, the applicability depends on the possibility to install closed underground storage for the circulating water.
f	Use of an air cleaning system, such as: 1. Wet acid scrubber; 2. Two-stage or three-stage air cleaning system; 3. Bioscrubber (or biotrickling filter).	May not be generally applicable due to the high implementation cost. Applicable to existing plants only where a centralised ventilation system is used.

(1) A description of the techniques is given in Sections 4.11 and 4.13.2.

Table 3.2

BAT-AEL for ammonia emissions to air from each house for broilers with a final weight of up to 2,5 kg

Parameter	BAT-AEL [1] [2] (kg NH_3/animal place/year)
Ammonia expressed as NH_3	0,01-0,08

(1) The BAT-AEL may not be applicable to the following types of farming: extensive indoor, free-range, traditional free-range and free-range — total freedom, as defined in Commission Regulation (EC) No 543/2008 of 16 June 2008 laying down detailed rules for the application of Council Regulation (EC) No 1234/2007 as regards the marketing standards for poultrymeat (OJ L 157, 17.6.2008, p. 46).
(2) The lower end of the range is associated with the use of an air cleaning system.

The associated monitoring is in BAT 25. The BAT-AEL may not be applicable to organic livestock production.

3.1.3. Ammonia emissions from houses for ducks

BAT 33. In order to reduce ammonia emissions to air from each animal house for ducks, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Applicability
a	One of the following techniques using natural or forced ventilation:	
	1. Frequent litter addition (in case of solid floor with deep litter or deep litter combined with slatted floor).	For existing plants with deep litter combined with slatted floor the applicability depends on the design of the existing structure.
	2. Frequent manure removal (in case of fully slatted floor).	Only applicable to the rearing of Barbary/Muscovy ducks (*Cairina Moschata*), for sanitary reasons.
b	Use of an air cleaning system, such as: 1. Wet acid scrubber; 2. Two-stage or three-stage air cleaning system; 3. Bioscrubber (or biotrickling filter).	May not be generally applicable due to the high implementation cost. Applicable to existing plants only where a centralised ventilation system is used.

(1) A description of the techniques is given in Sections 4.11 and 4.13.3.

3.1.4. Ammonia emissions from houses for turkeys

BAT 34. In order to reduce ammonia emissions to air from each animal house for turkeys, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Natural or forced ventilation with a non-leaking drinking system (in case of solid floor with deep litter).	Natural ventilation is not applicable to plants with a centralised ventilation system. Natural ventilation may not be applicable during the initial stage of rearing or due to extreme climate conditions.
b	Use of an air cleaning system, such as: 1. Wet acid scrubber; 2. Two-stage or three-stage air cleaning system; 3. Bioscrubber (or biotrickling filter).	May not be generally applicable due to the high implementation cost. Applicable to existing plants only where a centralised ventilation system is used.

(1) A description of the techniques is given in Sections 4.11 and 4.13.4.

4. DESCRIPTION OF TECHNIQUES

4.1. Techniques for reducing emissions from waste water

Technique	Description
Minimise use of water.	The volume of waste water can be reduced by using techniques such as pre-cleaning (e.g. mechanical dry cleaning) and high pressure cleaning.
Segregate rainwater from waste water streams that require treatment.	Segregation is carried out by implementing separate collection in the form of properly designed and maintained drainage systems.
Treat waste water.	Treatment can be performed by sedimentation and/or biological treatment. For waste water with a low pollutant load, treatment can be carried out by means of swales, ponds, constructed wetlands, soakaways, etc. A first flush system can be used for separation before biological treatment.
Landspreading of waste water e.g. by using an irrigation system such as sprinkler, travelling irrigator, tanker, umbilical injector.	Waste water streams can be settled, e.g. in tanks or lagoons, before landspreading. The resulting solid fraction can also be landspread. The water can be pumped from the stores and brought into a pipeline that goes to e.g. a sprinkler or travelling irrigator, which landspreads the water at a low application rate. Irrigation can also be carried out using equipment with controlled application to ensure a low trajectory (low spread pattern) and large droplets.

4.2. Techniques for efficient use of energy

Technique	Description
Optimisation of heating/cooling and ventilation systems and management, especially where air cleaning systems are used.	This takes into account animal welfare requirements (e.g. concentration of air pollutants, appropriate temperatures), and can be obtained through several measures: — automation and minimisation of the air flow, while maintaining thermal comfort zone for the animals; — fans with the lowest possible specific power consumption; — flow resistance is kept as low as possible; — frequency converters and electronically commutated motors; — energy-saving fans controlled according to the CO_2 concentration in the housing; — correct distribution of heating/cooling and ventilation equipment, temperature sensors and separate heated areas.
Insulation of walls, floors and/or ceilings of housing.	Insulation material can be naturally impermeable or provided with an impermeable coating. Permeable materials are provided with a vapour barrier installed, as humidity is a major cause of insulation material deterioration. A variant of insulation material for poultry farms can be heat-reflecting membranes, consisting of laminated plastic foils to seal off housing from air leakage and humidity.

Technique	Description
Use of energy-efficient lighting.	More energy-efficient lighting can be attained by: i. Replacing conventional tungsten light bulbs or other low efficiency light bulbs with more energy-efficient lights such as fluorescent, sodium, and LED lights; ii. Using devices to adjust the frequency of micro flashes, dimmers to adjust artificial lighting, sensors or room entry switches to control the lighting; iii. Allowing more natural light to enter, e.g. by using vents or roof windows. Natural light has to be balanced with potential heat losses; iv. Applying lighting schemes, using a variable lighting period.
Use of heat exchangers. One of the following systems may be used: — air-air; — air-water; — air-ground.	In an air-air heat exchanger, the incoming air absorbs heat from the exhaust air from the plant. It can be composed of plates of anodised aluminium or PVC tubes. In the air-water heat exchanger, water flows through aluminium fins located in the exhaust ducts and absorbs heat from the exhausted air. In the air-ground heat exchanger, fresh air is circulated through buried pipes (e.g. at a depth of about 2 metres) taking advantage of the low seasonal temperature variation of soil.
Use of heat pumps for heat recovery.	Heat is absorbed from various media (water, slurry, ground, air, etc.) and transferred to another location, via a fluid circulated in a sealed circuit using the reverse refrigeration cycle principle. The heat can be used to produce sanitised water or to feed a heating system or a cooling system. The technique can absorb heat from various circuits, such as slurry cooling systems, geothermal energy, scrubbing water, slurry biological treatment reactors, or biogas engine exhaust gases.
Heat recovery with heated and cooled littered floor (combideck system).	A closed water circuit is installed below the floor and another is built at a deeper level for storing the excess heat or to return it to the poultry house when needed. A heat pump connects the two water circuits. At the beginning of the rearing period, the floor is heated with the stored heat in order to keep the litter dry by avoiding moisture condensation; during the second rearing cycle, birds produce an excess of heat that is preserved in the storing circuit while cooling down the floor which reduces the breakdown of uric acid by reducing microbial activity.
Apply natural ventilation.	Free ventilation in the animal house is caused by thermal effects and/or wind flow. The animal houses can have openings in the ridge and, if necessary, also on the gable sides in addition to controllable openings in the side walls. The openings can be equipped with wind protection nets. Fan assistance can be used during hot weather.

4.3. Techniques for reducing dust emissions

Technique	Description
Water fogging	Water is sprayed by nozzles at high pressure to produce fine droplets that absorb heat and fall by gravity to the floor, moistening dust particles that become heavy enough to drop as well. Wet or moist litter needs to be avoided.
Ionisation	An electrostatic field is created in the house to produce negative ions. Circulating airborne dust particles are charged by free negative ions; particles are collected on the floor and room surfaces by gravitational force and electrostatic field attraction.
Oil spraying	Pure vegetable oil is sprayed by nozzles inside the house. A mixture of water and around 3 % vegetable oil can be also used for spraying. Circulating dust particles are bound to the oil drops and collected in the litter. A thin layer of vegetable oil is also applied on the litter to prevent dust emissions. Wet or moist litter needs to be avoided.

4.4. Techniques for reducing odour emissions

Technique	Description
Ensure adequate distances between the plant/farm and the sensitive receptors.	At the planning stage of the plant/farm, adequate distances between the plant/farm and the sensitive receptors are ensured by applying minimum standard distances or performing dispersion modelling to predict/simulate odour concentration in surrounding areas.
Cover slurry or solid manure during storage.	See description in Section 4.5 for solid manure. See description in Section 4.6 for slurry.
Minimise stirring of slurry.	See description in Section 4.6.1.
Aerobic digestion (aeration) of liquid manure/slurry.	See description in Section 4.7.
Compost solid manure.	
Anaerobic digestion.	
Band spreader, shallow injector or deep injector for slurry landspreading.	See descriptions in Section 4.8.1.
Incorporate manure as soon as possible.	See descriptions in BAT 22.

4.5. Techniques for reducing emissions from the storage of solid manure

Technique	Description
Store dried solid manure in a barn.	The barn is usually a simple construction with an impermeable floor and a roof, with sufficient ventilation to avoid anaerobic conditions and an access door for transport. Dried poultry manure (e.g. litter from broilers and laying hens, air-dried laying hen excreta collected on belts) is transported by belts or front-end loaders from the poultry house to the barn where it can be stored for a long period of time without the risk of remoistening.
Use a concrete silo for storage.	A foundation slab of water-impermeable concrete that can be combined with walls on three sides and with a cover e.g. roofing over the manure platform, UV-stabilised plastic, etc. The floor is sloped (e.g. 2 %) towards a front drain gutter. Liquid fractions and any run-off caused by rainfall are collected in a leak-tight concrete pit and handled afterwards.
Store solid manure on solid impermeable floor equipped with a drainage system and a collection tank for run-off.	The storage is equipped with a solid impermeable floor, a drainage system such as drains, and connected to a tank for collection of liquid fractions and any run-off caused by rainfall.
Select a storage facility with a sufficient capacity to hold the manure during periods in which landspreading is not possible.	The periods when manure landspreading is allowed depend on the local climatic conditions and legislation, etc.; thus, requiring a storage area with a suitable capacity. The available capacity also allows the landspreading time to be aligned to the nitrogen requirements of the crops.
Store solid manure in field heaps placed away from surface and/or underground watercourses which liquid run-off might enter.	Solid manure is stacked directly on the soil in the field prior to landspreading over a limited period of time (e.g. for a few days or several weeks). The storage location is changed at least every year and situated as far as possible from surface and groundwater.
Reduce the ratio between the emitting surface area and volume of the manure heap.	Manure can be compacted or a three-sided wall store can be used.
Cover solid manure heaps.	Materials such as UV-stabilised plastic covers, peat, sawdust, or wood chips can be used. Tight covers decrease air exchange and aerobic decomposition in the manure heap, resulting in a reduction of emissions to air.

4.6. Techniques for reducing emissions from slurry storage

4.6.1. Techniques for reducing ammonia emissions from slurry stores and earth-banked storage

Technique	Description
Reduce the ratio between the emitting surface area and the volume of the slurry store.	For rectangular slurry stores, the proportion of height and surface area is equivalent to 1:30-50. For circular stores, favourable container dimensions are obtained with a height — diameter ratio of 1:3 to 1:4. The side walls of the slurry store may be increased in height.

Technique	Description
Reduce wind velocity and air exchange on the slurry surface by operating at a lower level of fill.	Increasing the freeboard (the length between the slurry surface and the upper rim of the slurry store) of the uncovered store provides a windshield effect.
Minimise stirring of slurry.	Keep the stirring of slurry to a minimum. This practice involves: — filling the store below surface level; — discharging as close as possible to the base of the store; — avoiding unnecessary homogenisation and circulation of slurry (before emptying the slurry store).
Rigid cover.	A roof or a lid which can be made of concrete, fibreglass panels or polyester sheets with a flat deck or conical shape, applied to concrete or steel tanks and silos. It is well-sealed and 'tight' to minimise air exchange and to prevent rain and snow from entering.
Flexible covers.	Tent Cover: a cover with a central supporting pole and spokes radiating from the tip. A fabric membrane is spread over the spokes and tied to a rim brace. Non-covered openings are kept to a minimum. Dome-shaped cover: a cover with a curved structural frame installed over round stores with the use of steel components and bolted joints. Flat cover: a cover consisting of a flexible and self-supporting composite material held by plugs on a metal structure.
Floating covers.	
Natural crust.	A crust layer can be formed on the surface of slurry that has a sufficient dry matter (DM) content (at least 2 %) depending on the nature of the slurry solids. In order to be effective, the crust must be thick, not be disturbed and cover the whole slurry surface. The store is filled from below the surface once the cover is formed to avoid breaking it up.
Straw.	Chopped straw is added to the slurry and a straw-induced crust is formed. This generally works well for DM higher than 4-5 %. A layer thickness of at least 10 cm is recommended. Air blowing can be reduced by adding straw at the time of slurry addition. Straw layers may need to be partially or completely renewed during the year. The store is filled from below the surface once the cover is formed to avoid breaking it up.
Plastic pellets.	Polystyrene balls of 20 cm in diameter and 100 g in weight are used to cover the slurry surface. A regular replacement of deteriorated elements and a refill for uncovered spots are necessary.
Light bulk materials.	Materials such as LECA (Light expanded clay aggregates), LECA based products, perlite or zeolite are added to the slurry surface to form a floating layer. A floating layer of 10-12 cm is recommended. A thinner layer can be effective for smaller LECA particles.

Technique	Description
Floating flexible covers.	Plastic floating covers (e.g. blankets, canvas, films) rest over the slurry surface. Floats and tubes are installed to keep the cover in place, while maintaining a void beneath the cover. This technique can be combined with stabilising elements and structures to allow vertical movements. Venting is needed as well as removal of rainwater that gathers on top.
Geometrical plastic tiles.	Floating hexagonal plastic bodies are automatically distributed on the slurry surface. About 95 % of the surface can be covered.
Air-inflated cover.	A cover made of PVC fabric supported by an inflatable pocket that floats over the slurry. The fabric is fixed by guy ropes to a peripheral metal structure.
Flexible plastic sheets.	Impermeable UV-stabilised plastic sheets (e.g. HDPE) are secured at the bank tops and supported on floats. This prevents the cover from turning during manure mixing and being lifted off by wind. The covers can also be fitted with collection piping for removal of gases, other maintenance openings (e.g. for the use of homogenisation equipment) and a system for rainwater collection and removal.

4.6.2. Techniques for reducing emissions to soil and water from slurry stores

Technique	Description
Use stores that are able to withstand mechanical, chemical and thermal influences.	Appropriate concrete mixtures and, in many cases, lining on concrete walls or impermeable layers on steel sheets can be applied.
Select a storage facility with a sufficient capacity to hold the manure during periods in which landspreading is not possible.	See Section 4.5.

4.7. Techniques for on farm manure processing

Technique	Description
Mechanical separation of slurry.	Separation of liquid and solid fractions with different dry matter content, using e.g. screw press separators, decanter-centrifuge separators, separation by sieves and filter pressing. Separation can be enhanced by coagulation-flocculation of solid particles.
Anaerobic digestion of manure in a biogas installation.	Anaerobic microorganisms decompose the organic matter of manure in a closed reactor in the absence of oxygen. Biogas is produced and collected to serve energy generation i.e. production of heat, combined heat and power, and/or transport fuel. Some of the heat produced is recycled in the process. The stabilised residue (digestate) can be used as fertiliser (with sufficiently solid digestate after composting). Solid manure can be co-digested with slurry and/or other co-substrates, while ensuring a dry matter content lower than 12 %.
Use of an external tunnel for manure drying.	Manure is collected from the laying hen houses and removed by belts that convey it outdoors to a dedicated closed structure, containing a series of perforated overlapping belts that form the tunnel. Warm air is blown through the belts, drying the manure in about two or three days. The tunnel is ventilated with air extracted from the laying hens' house.

Technique	Description
Aerobic digestion (aeration) of slurry.	The biological decomposition of organic matter under aerobic conditions. Stored slurry is aerated by means of submerged or floating aerators in a continuous or batch process. Operating variables are controlled to prevent nitrogen removal, such as keeping slurry agitation as low as possible. The residue can be used as fertiliser (composted or not) after concentration.
Nitrification-denitrification of slurry.	Part of the organic nitrogen is transformed into ammonium. Ammonium is oxidised by nitrifying bacteria into nitrite and nitrate. By applying anaerobic periods, the nitrate can be transformed into N_2 in the presence of organic carbon. In a secondary basin, the sludge settles, with part of it being reused in the aeration basin. The residue can be used as fertiliser (composted or not) after concentration.
Composting of solid manure.	The controlled aerobic decomposition of solid manure by microorganisms producing a final product (compost) sufficiently stable for transport, storage and landspreading. Odour, microbial pathogens and water content of manure are reduced. The solid fraction of the slurry can also be composted. The supply of oxygen is achieved by mechanical reversal of the windrows or by forced aeration of the heaps. Drums and composting tanks can also be used. Biological inoculum, green residues or other organic wastes (e.g. digestate) can be co-composted with solid manure.

4.8. **Techniques for manure landspreading**

4.8.1. Techniques for slurry landspreading

Technique	Description
Slurry dilution	Dilution rate of water: slurry is from 1:1 up to 50:1. The dry matter content of diluted slurry is less than 2 %. The clarified liquid fraction from the mechanical separation of slurry and the digestate from anaerobic digestion can be used as well.
Low-pressure water irrigation system	Diluted slurry is injected into the irrigation water pipeline and is pumped under low pressure to the irrigation system (e.g. sprinkler or travelling irrigator).
Band spreader (trailing hose)	A series of flexible hoses hang from a wide bar mounted onto the slurry trailer. The hoses discharge slurry at ground level in wide parallel bands. Application between the rows of a growing arable crop is feasible.
Band spreader (trailing shoe)	Slurry is discharged through rigid pipes which terminate in metal 'shoes', designed to apply slurry directly in narrow bands to the soil surface and below the crop canopy. Some types of trailing shoes are designed to cut a shallow slit in the soil to aid infiltration.
Shallow injector (open slot)	Tines or disc harrows are used to cut vertical slots (typically 4-6 cm deep) in the soil, forming grooves into which slurry is deposited. The injected slurry is fully or partially placed below the soil surface and grooves will normally be open after slurry application.

Technique	Description
Deep injector (closed slot)	Tines or disc harrows are used to cultivate the soil and deposit slurry into it, before covering the slurry fully by means of press wheels or rollers. The depth of the closed slot ranges between 10 cm and 20 cm.
Slurry acidification	See Section 4.12.3.

4.9. **Techniques for monitoring**

4.9.1. Techniques for monitoring N and P excretion

Technique	Description
Calculation by using a mass balance of nitrogen and phosphorus based on feed intake, crude protein content of the diet, total phosphorus and animal performance.	The mass balance is calculated for each animal category reared on the farm, coinciding with the end of a rearing cycle, on the basis of the following equations: $N_{excreted} = N_{diet} - N_{retention}$ $P_{excreted} = P_{diet} - P_{retention}$ N_{diet} is based on the amount of feed ingested and on the crude protein content of the diet. P_{diet} is based on the amount of feed ingested and on the total phosphorus content of the diet. The crude protein and the total phosphorus contents can be obtained by one of the following methods: — in the case of external feed supply: in the accompanying documentation; — in the case of self-processing of feed: by sampling of feedstuff compounds from the silos or the feeding system for analysing the total content of phosphorus and crude protein or, alternatively, in the accompanying documentation or using standard values of total content of phosphorus and crude protein of the feedstuff compounds. $N_{retention}$ and $P_{retention}$ can be estimated by one of the following methods: — statistically derived equations or models; — standard retention factors for the nitrogen and phosphorus contents of the animal (or of eggs, in the case of laying hens); — analysis for nitrogen and phosphorus contents of a representative sample of the animal (or of eggs, in the case of laying hens). The mass balance considers especially any significant changes to the diet commonly applied (e.g. change of a compound feed).
Estimation by using manure analysis for total nitrogen and total phosphorus contents.	The total content of nitrogen and phosphorus of a representative composite sample of manure is measured — and the total excretion of nitrogen and phosphorus is estimated — based on records for the volume (for slurry) or weight (for solid manure) of manure. For solid manure systems, the nitrogen content of litter is also considered. In order for the composite sample to be representative, samples must be taken from at least 10 different places and/or depths to make the composite sample. In the case of poultry litter, the bottom of the litter is sampled.

4.9.2. Techniques for ammonia and dust monitoring

Technique	Description
Estimation by using a mass balance based on the excretion and the total (or ammoniacal) nitrogen present at each manure management stage.	Ammonia emissions are estimated based on the amount of nitrogen excreted by each animal category and using the total nitrogen (or the total ammoniacal nitrogen — TAN) flow and the volatilisation coefficients (VC) over each manure management stage (housing, storage, landspreading). The equations applied for each of the manure management stages are: $E_{housing} = N_{excreted} \cdot VC_{housing}$ $E_{storage} = N_{storage} \cdot VC_{storage}$ $E_{spreading} = N_{spreading} \cdot VC_{spreading}$ where: E is the annual NH_3 emission from the animal house, manure storage or landspreading (e.g. in kg NH_3/animal place/year). N is the annual total nitrogen or TAN excreted, stored or applied in landspreading (e.g. in kg N/animal place/year). If appropriate, nitrogen additions (e.g. related to litter, recycling of scrubbing liquids) and/or nitrogen losses (e.g. related to manure processing) can be considered. VC is the volatilisation coefficient (dimensionless, related to the housing system, manure storage or landspreading techniques) representing the proportion of TAN or total N emitted to air. VC are derived from measurements designed and performed according to a national or an international protocol (e.g. VERA protocol) and validated for a farm with an identical type of technique and similar climatic conditions. Alternatively, information to derive VC can be taken from European or other internationally recognised guidance. The mass balance considers especially any significant change to the type of livestock reared at the farm and/or to the techniques applied for housing, storage and landspreading.
Calculation by measuring the ammonia (or dust) concentration and the ventilation rate using ISO, national or international standard methods or other methods ensuring data of an equivalent scientific quality.	Ammonia (or dust) samples are taken on six days, as a minimum, distributed over one year. Sampling days are distributed as follows: — For animal categories with a stable emissions pattern (e.g. laying hens), the sampling days are randomly selected in every two-month period. The daily average is calculated as a mean over all sampling days. — For animal categories with a linear increase in emissions during the rearing cycle (e.g. fattening pigs), the sampling days are equally distributed over the growing period. In order to achieve this, half the measurements are performed in the first half of the rearing cycle, and the remainder in the second half of the rearing cycle. The sampling days in the second half of the rearing cycle are equally distributed within the year (same number of measurements per season). The daily average is calculated as a mean over all sampling days. — For animal categories with an exponential increase in emissions (e.g. broilers), the rearing cycle is divided into three periods of equal length (same number of days). One measurement day falls in the first period, two measurements in the second period, and three measurements in the third period. In addition, sampling days in the third period of the rearing cycle are equally distributed within the year (same number of measurements per season). The daily average is calculated as the average of the three periodic means.

Technique	Description
	Sampling is based on 24-hour sampling periods and is performed at the air inlet/outlet. Ammonia (or dust) concentration at the air outlet is then measured, corrected for the concentration of the incoming air, and daily ammonia (or dust) emissions are derived by measuring and multiplying the ventilation rate and the ammonia (or dust) concentration. From the daily average of ammonia (or dust) emissions, the yearly average ammonia (or dust) emissions from an animal house can be calculated, if multiplied by 365 and corrected for any non-occupation periods. The ventilation rate, necessary to determine the emission mass flow, is determined either by calculation (e.g. fan wheel anemometer, records of ventilation control system) in forced ventilated houses, or by means of tracer gases (excluding the use of SF_6 and any gas containing CFCs) in naturally ventilated houses which allow a proper mixing of air. For plants with multiple air inlets and outlets, only those sampling points considered representative (in terms of expected mass emissions) of the plant are monitored.
Estimation by using emission factors.	Ammonia (or dust) emissions are estimated on the basis of emission factors derived from measurements designed and performed according to a national or an international protocol (e.g. VERA protocol) in a farm with an identical type of technique (related to the housing system, manure storage and/or landspreading) and similar climatic conditions. Alternatively, emission factors can be taken from European or other internationally recognised guidance. The use of emission factors considers especially any significant change to the type of livestock reared at the farm and/or to the techniques applied for housing, storage, landspreading.

4.9.3. Techniques for monitoring of air cleaning systems

Technique	Description
Verification of the air cleaning system performance by measuring ammonia, odour and/or dust under practical farm conditions, according to a prescribed measurement protocol and using EN standard methods or other methods (ISO, national or international) ensuring data of an equivalent scientific quality.	The verification is done by measurement of ammonia, odour and/or dust in the inlet and outlet air and of all additional parameters relevant for operation (e.g. air flow rate, pressure drop, temperature, pH level, conductivity). Measurements are performed under summer climatic conditions (a period of at least eight weeks with a ventilation rate > 80 % of the maximum ventilation rate) and winter climatic conditions (a period of at least eight weeks with a ventilation rate < 30 % of the maximum ventilation rate), with representative management and full capacity of the housing and only if an adequate time period (e.g. four weeks) has elapsed after the last change of wash water. Different sampling strategies can be applied.
Control of the effective function of the air cleaning system (e.g. by continuously recording operational parameters or using alarm systems).	Operation of an electronic logbook in order to record all measuring and operational data over a period of 1-5 years. Recorded parameters depend on the type of air cleaning system and may include: 1. pH and conductivity of scrubbing liquid; 2. air flow and pressure drop of the abatement system;

Technique	Description
	3. pump operating time; 4. water and acid consumption. Other parameters can be recorded manually.

4.10. **Nutritional management**

4.10.1. Techniques for reducing nitrogen excreted

Technique	Description
Reduce the crude protein content by using a N-balanced diet based on the energy needs and digestible amino acids.	Reduce excesses in the crude protein supply by ensuring that it does not exceed feeding recommendations. The diet is balanced to meet the animal requirements of energy and digestible amino acids.
Multiphase feeding with a diet formulation adapted to the specific requirements of the production period.	The feed mix matches the animal requirements more accurately in terms of energy, amino acids and minerals, depending on the animal weight and/or production stage.
Addition of controlled amounts of essential amino acids to a low crude protein diet.	A certain amount of protein-rich feedstuffs is substituted by low-protein feedstuffs, in order to further reduce the crude protein content. The diet is supplemented with synthetic amino acids (e.g. lysine, methionine, threonine, tryptophan, valine) so that there is no deficiency in the amino acid profile.
Use of authorised feed additives which reduce total nitrogen excreted.	Authorised (according to Regulation (EC) No 1831/2003 of the European Parliament and of the Council (1)) substances, microorganisms or preparations such as enzymes (e.g. NSP enzymes, proteases) or probiotics are added to feed or water in order to favourably affect feed efficiency e.g. by improving the digestibility of feedstuffs or affecting the gastrointestinal flora.

(1) Regulation (EC) No 1831/2003 of the European Parliament and of the Council of 22 September 2003 on additives for use in animal nutrition (OJ L 268, 18.10.2003, p. 29).

4.10.2. Techniques for reducing phosphorus excreted

Technique	Description
Multiphase feeding with a diet formulation adapted to the specific requirements of the production period.	The feed consists of a mix matching the phosphorus supply to the phosphorus animal requirements more accurately depending on the animal weight and/or production stage.
Use of authorised feed additives which reduce total phosphorus excreted (e.g. phytase).	Authorised (according to Regulation (EC) No 1831/2003) substances, microorganisms or preparations such as enzymes (e.g. phytase) are added to feed or water in order to favourably affect feed efficiency e.g. by improving the digestibility of phytic phosphorus in the feedstuffs or affecting the gastrointestinal flora.

4.11. Techniques to treat emissions to air from animal housing

Technique	Description
Biofilter	The exhaust air is led through a filter bed of organic material, such as root wood or wood chips, coarse bark, compost or peat. The filter material is always kept moist by intermittent sprinkling of the surface. Dust particles and odorous air compounds are absorbed by the wet film and are oxidised or degraded by microorganisms living on the moistened litter material.
Bioscrubber (or biotrickling filter)	A packed tower filter with inert packing material which is normally maintained continuously wet by sprinkling water. Air pollutants are absorbed in the liquid phase and subsequently degraded by microorganisms settling on the filter elements. An ammonia reduction of between 70 % and 95 % can be achieved.
Dry filter	The exhaust air is blown against a screen made of e.g. multi-layered plastic placed in front of the end wall ventilator. The passing air is subject to strong changes of direction causing the separation of particles by centrifugal force.
Two-stage or three-stage air cleaning system	In a two-stage system, the first stage (wet acid scrubber) is usually combined with a bioscrubber (second stage). In a three-stage system, a first stage consisting of a water scrubber is usually combined with a second stage (wet acid scrubber), followed by a biofilter (third stage). An ammonia reduction of between 70 % and 95 % can be achieved.
Water scrubber	The exhaust air is blown through a packed filter medium by transverse flow. Water is continuously sprayed on the packing material. Dust is removed and settles in the water tank, which is emptied before refilling.
Water trap	The exhaust air is directed by ventilation fans down onto a water bath where dust particles get soaked. The flow is then redirected 180 degrees upward. The water level is topped up regularly to compensate for evaporation.
Wet acid scrubber	The exhaust air is forced through a filter (e.g. packed wall) where a circulating acid liquid (e.g. sulphuric acid) is sprayed. An ammonia reduction of between 70 % and 95 % can be achieved.

4.12. Techniques for pig houses

4.12.1. Description of floor types and techniques for reducing ammonia emissions in pig houses

Type of floor	Description
Fully slatted floor	A floor where the whole area is slatted using metal, concrete or plastic floor with openings that allows faeces and urine to drop into a channel or a pit beneath.

Type of floor	Description
Partly slatted floor	A floor that is partly solid and partly slatted using metal, concrete or plastic floor with openings that allows faeces and urine to drop into a channel or a pit beneath. Fouling of the solid floor is prevented by proper management of the indoor climate parameters, especially under hot conditions, and/or by proper design of the housing systems.
Solid concrete floor	A floor where the entire area consists of solid concrete. The floor can be covered with litter (e.g. straw) to varying degrees. The floor is usually sloped to facilitate the drainage of urine.

The floor types listed above are used in the described housing systems, when appropriate:

Technique	Description
A deep pit (in case of a fully or partly slatted floor) only if used in combination with an additional mitigation measure, e.g.: — a combination of nutritional management techniques; — air cleaning system; — pH reduction of the slurry; — slurry cooling.	Pens are equipped with a deep pit below the slatted floor that allows for the storage of the slurry between infrequent removals. For fattening pigs, an overflow manure channel can be used. Removal of slurry for landspreading or to outdoor store takes place as frequent as possible (e.g. at least every two months) unless there are technical restrictions (e.g. storage capacity).
A vacuum system for frequent slurry removal (in case of a fully or partly slatted floor).	Outlets at the bottom of the pit or channel are connected to a discharge pipe underneath which transfers slurry to outdoor storage. Slurry is frequently discharged by opening a valve or a plug in the main slurry pipe, e.g. once or twice every week; a slight vacuum develops and allows the complete emptying of the pit or channel. A certain depth of slurry needs to be obtained before the system can operate properly to allow the vacuum to be effective.
Slanted walls in the manure channel (in case of a fully or partly slatted floor).	The manure channel creates a V section with the point of discharge at the bottom. The slope and the smoothness of the surface facilitate the slurry discharge. Manure removal is carried out at least twice every week.
A scraper for frequent slurry removal (in case of a fully or partly slatted floor).	There is a V-shaped channel with two inclined surfaces on each side of a central gutter, where urine can be drained to a collection pit through a drain in the bottom of the manure channel. From the pit, the solid fraction of the manure is extracted frequently (e.g. daily) by a scraper. The addition of a coating on the scraped floor is recommended in order to achieve a smooth(er) surface.

Technique	Description
Convex floor and separated manure and water channels (in case of partly slatted pens).	Manure and water channels are built at opposite sides of the convex and smooth solid concrete floor. The water channel is installed underneath the side of the pen where the pigs tend to eat and drink. Water for cleaning the pens may be used to fill the water channels. The channel is partially filled with at least 10 cm of water. The manure channel can be built with flashed gutters or slanted walls which are normally flushed twice every day for example with water from the other channel or the liquid fraction of the slurry (dry matter content no higher than approximately 5 %).
V-shaped manure belts (in case of partly slatted floor).	V-shaped manure belts roll inside the manure channels covering the whole surface, so that all faeces and urine are dropped on them. Belts are run at least twice every day to separately carry urine and faeces to closed manure storage. Belts are made of plastic (polypropylene or polyethylene).
Reduced manure pit (in case of partly slatted floor).	The pen is equipped with a narrow pit with a width of about 0,6 m. The pit can be placed in an external alley.
Frequent slurry removal by flushing (in case of fully or partly slatted floor).	A very frequent removal (e.g. once or twice per day) of the slurry is performed by flushing the channels with the liquid fraction of the slurry (dry matter content no higher than approximately 5 %) or water. The liquid fraction of the slurry can also be aerated before flushing. This technique can be combined with individual variations of the bottoms of channels or pits, e.g. gutters, tubes or a permanent slurry layer.
Kennel/hut housing (in case of partly slatted floor).	Separate functional areas are organised in the pens of naturally ventilated houses. The lying area (about 50-60 % of the total area) consists of a levelled insulated concrete floor with covered, insulated huts or kennels, with a hinged roof that can be raised or lowered to control temperature and ventilation. The activity and feeding areas lie on a slatted floor with a manure pit underneath and frequent manure removal, e.g. by vacuum. Straw can be used on the solid concrete floor.
Full litter system (in case of solid concrete floor).	A fully concrete floor almost completely covered with a layer of straw or other lignocellulosic material. In the litter-floored system, solid manure is frequently removed (e.g. twice per week). Alternatively in the deep litter system, fresh straw is added on top and the accumulated manure is removed at the end of the rearing cycle. Separate functional areas can be organised into lying, feeding, walking and defecating areas.
Littered external alley (in case of solid concrete floor).	A small door allows the pig to go out to defecate in an external alley with a concrete littered floor. The manure falls into a channel from where it is scraped once every day.
Feeding/lying boxes on solid floor (in case of litter-based pens).	Sows are kept in a pen divided into two functional areas, the main one littered and a series of feeding/lying boxes over a solid floor. Manure is captured in the straw or other lignocellulosic material, which is regularly supplied and replaced.

Technique	Description
Manure collection in water.	Manure is collected in the cleaning water that is kept in the manure channel and refilled up to a level of around 120-150 mm. Slanted channel walls are optional. After each rearing cycle, the manure channel is emptied.
A combination of water and manure channels (in case of fully slatted floor).	The sow is kept in a fixed place (by using a farrowing crate) with a specific defecating area. The manure pit is split up into a wide water channel at the front and a small manure channel at the back, with a reduced manure surface. The front channel is partly filled with water.
Manure pan (in case of fully or partly slatted floor).	A prefabricated pan (or pit) is placed under the slatted floor. The pan is deepest at one end with a slope of at least 3° towards a central manure channel; the manure discharges when its level reaches around 12 cm. If a water channel exists, the pan can be subdivided into a water section and a manure section.
Straw flow system (in case of solid concrete floor).	Pigs are reared in pens with solid floors, where a sloped lying area and an excretion area are defined. Straw is provided to the animals daily. Pig activity pushes and distributes the litter down the pen's slope (4-10 %) to the manure collection aisle. The solid fraction can be removed frequently (e.g. daily) with a scraper.
Littered pens with combined manure generation (slurry and solid manure).	Farrowing pens are equipped with separate functional areas: a bedded lying area, walking and dung areas with slatted or perforated floors, and a feeding area on a solid floor. Piglets are provided with a littered and covered nest. Slurry is frequently removed with a scraper. Solid manure is manually removed from the solid floor areas on a daily basis. Litter is regularly provided. A yard can be combined with the system.
Use of floating balls in the manure channel.	Balls half-filled with water and made of special plastic with non-sticky coating, float on the surface of the manure channels.

4.12.2. Techniques for cooling slurry

Technique	Description
Slurry cooling pipes	A reduction of slurry temperature (usually less than 12 °C) is achieved by installing a cooling system placed above the slurry, above the concrete floor or cast into the floor. The applied cooling intensity can be from 10 W/m^2 to 50 W/m^2 for gestating sows and fattening pigs housed on partly slatted floors. The system consists of pipes in which a refrigerant or water is circulated. The pipes are connected to a heat exchange device to recover energy that may be used for heating other parts of the farm. The pit or the channels need to be frequently emptied due to a relatively small exchanging surface of the pipes.

4.12.3. Techniques for reducing the pH of slurry

Technique	Description
Slurry acidification	Sulphuric acid is added to slurry in order to lower the pH to about 5,5 in the slurry pit. The addition can be carried out in a process tank, followed by aeration and homogenisation. Part of the treated slurry is pumped back to the storage pit under the housing floors. The treatment system is fully automated. Prior to (or after) landspreading on acid soils, lime addition may be required to neutralise the pH of the soil. Alternatively, acidification can be performed directly in the slurry store or continuously during landspreading.

4.13. Techniques for poultry housing

4.13.1. Techniques for reducing ammonia emissions from houses for laying hens, broiler breeders or pullets

Housing system	Description
Unenriched cage system	Broiler breeders are housed in unenriched cage systems fitted with perches, litter area and nest. Pullets should be given appropriate experience of management practices (e.g. particular feeding and watering systems) and environmental conditions (e.g. natural light, perches, litter) to enable them to adapt to the husbandry systems which they will encounter later in life. The cages are usually arranged on three or more tiers.
Enriched cage system	Enriched cages are built with sloping floors, are made of welded wire mesh or plastic slats and are equipped with fixtures and increased space for feeding, drinking, nesting, scratching, perching and egg collection. The capacity of the cages can vary from around 10 to 60 birds. The cages are usually arranged on three or more tiers.
Deep litter with manure pit	At least one-third of the total floor in the housing is covered with litter (e.g. sand, wood shavings, straw). The remaining floor area is slatted, with a manure pit underneath. Feeding and drinking fixtures are located over the slatted area. Additional structures can be present inside or outside the housing, such as verandas and free-range system.
Aviaries	Aviaries are divided into different functional areas for feeding, drinking, egg laying, scratching and resting. The usable area is increased by means of elevated slatted floors combined with tiers. The slatted area ranges between 30 % and 60 % of the total floor area. The remaining floor is typically littered. In plants for laying hens and broiler breeders, the system can be combined with verandas with or without free-range system.
Manure removal by belts (in case of enriched or unenriched cage systems) with at least: — one removal per week with air drying; or — two removals per week without air drying.	Belts are placed under the cages for manure removal. The frequency of removal can be once every week (with air drying) or more (without air drying). The collection belt may be ventilated for drying the manure. Whisk-forced air drying in the manure belt can be also used.
Manure belt or scraper (in case of deep litter with a manure pit).	Manure is removed by scrapers (periodically) or by belts (once every week for dried manure, twice every week without drying).
Forced ventilation system and infrequent manure removal (in case of deep litter with a manure pit) only if used in combination with an additional mitigation measure, e.g.: — achieving a high dry matter content of the manure; — an air cleaning system.	The deep litter system (see above for description) is combined with infrequent manure removal, e.g. at the end of the rearing cycle. A minimum dry matter content of manure of around 50-60 % is ensured. This is achieved by an appropriate forced ventilation system (e.g. fans and air extraction placed at floor level).

Housing system	Description
Forced air drying of manure via tubes (in case of deep litter with a manure pit).	The deep litter system (see above for description) is combined with manure drying by means of forced ventilation applied through tubes that blow air (e.g. at 17-20 °C and 1,2 m^3/bird) over the manure stored under the slatted floor.
Forced air drying of manure using perforated floor (in case of deep litter with a manure pit).	The deep litter system (see above for description) is equipped with a perforated floor placed underneath the manure which allows for forced air blowing from below. The manure is removed at the end of the rearing cycle.
Manure belts (in case of aviary).	Manure is collected on belts under the slatted floor and removed at least once every week by ventilated or not ventilated belts. Littered and solid floors can be combined in aviaries for pullets.
Forced drying of litter using indoor air (in case of solid floor with deep litter).	In a deep litter system without a manure pit, indoor air recirculation systems can be used to dry the litter, while meeting the physiological needs of the birds. To this end, fans, heat exchangers and/or heaters can be used.

4.13.2. Techniques for reducing ammonia emissions from broiler houses

Technique	Description
Natural or forced ventilation with a non-leaking drinking system (in case of solid floor with deep litter).	The building is closed and well-insulated, equipped with natural or forced ventilation, and can be combined with a veranda and/or a free-range system. The solid floor is fully covered with litter which can be added to upon necessity. Floor insulation (e.g. concrete, clay, membrane) prevents water condensation in the litter. Solid manure is removed at the end of the rearing cycle. The design and operation of the drinking water system prevents leakage and spillage of water on the litter.
Forced drying system of litter using indoor air (in case of solid floor with deep litter).	Indoor air recirculation systems can be used to dry the litter, while meeting the physiological needs of the birds. To this end, fans, heat exchangers and/or heaters can be used.
Litter on manure belt and forced air drying (in case of tiered floor systems).	A multi-floor system on tiers equipped with manure belts covered with litter. Corridors for ventilation are left between the rows of tiers. Air enters through one corridor and is directed to the litter material on the manure belt. Litter is removed at the end of the rearing cycle. The system can be used in combination with a separate initial stage where broiler chicks are hatched and grown for a limited time on manure belts with litter on a multi-tiered system.
Heated and cooled littered floor (in case of combideck systems).	See Section 4.2.

4.13.3. Techniques for reducing ammonia emissions from duck houses

Technique	Description
Frequent litter addition (in case of solid floor with deep litter or deep litter combined with slatted floor).	Litter is maintained dry by frequent addition (e.g. daily) of fresh material upon necessity. Solid manure is removed at the end of the rearing cycle. The housing system can be equipped with natural or forced ventilation and combined with a free-range system. In case of deep litter combined with slatted floor, the floor is equipped with slats in the drinker area (about 25 % of the total floor area).
Frequent manure removal (in case of fully slatted floor).	Slats cover the pit where the manure is stored and evacuated to the external store. Frequent manure removal to an external store can be done: 1. by permanent gravity flow; 2. by scraping with variable frequencies. The housing system can be equipped with natural or forced ventilation and combined with a free-range system.

4.13.4. Techniques for reducing ammonia emissions from turkey houses

Technique	Description
Natural or forced ventilation with a non-leaking drinking system (in case of solid floor with deep litter).	The solid floor is fully covered with litter which can be added upon necessity. Floor insulation (by e.g. concrete, clay) prevents water condensation in the litter. Solid manure is removed at the end of the rearing cycle. The design and operation of the drinking water system prevents leakage and spillage of water on the litter. Natural ventilation can be combined with a free-range system.