ATTACHMENT NO. 4

SECTIONS OF BAT REFERENCE DOCUMENT

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Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs

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EXECUTIVE SUMMARY

The Intensive Rearing of Poultry and Pigs (ILF) BREF (Best Available Techniques reference document) reflects an information exchange carried out under Article 16(2) of Council Directive 96/61/EC. This executive summary – which is intended to be read in conjunction with the BREF Preface's explanation of objectives, usage and legal terms – describes the main findings, the principal BAT conclusions and the associated emission/consumption levels. It can be read and understood as a stand-alone document but, as a summary, it does not present all the complexities of the full BREF text. It is therefore not intended as a substitute for the full BREF text as a tool in BAT decision making.

Scope of work

The scope of the BREF for intensive livestock is based on Section 6.6 of Annex I of the IPPC Directive 96/61/EC as 'Installations for the intensive rearing of poultry or pigs with more than:
(a) 40000 places for poultry
(b) 2000 places for production pigs (over 30 kg), or
(c) 750 places for sows.'

The Directive does not define the term 'poultry'. From the discussion in the Technical Working Group (TWG) it was concluded that in this document the scope of poultry is chicken laying hens and broilers, turkeys, ducks and Guinea fowls. However, only laying hens and broilers are considered in detail in this document because of a lack of information on turkeys, ducks and Guinea fowls. The production of pigs includes the rearing of weaners, whose growing/finishing starts at a weight that varies between 25 and 35 kg of live weight. The rearing of sows includes mating, gestating and farrowing sows and gilts.

Structure of the industry

Farming in general

Farming has been and still is dominated by family run businesses. Until the sixties and into the early seventies, poultry and pig production were only part of the activities of a mixed farm, where crops were grown and different animal species were kept. Feed was grown on the farm or purchased locally and residues of the animal were returned to the land as fertiliser. Only a very small number of this type of farm may still exist in the EU, because increasing market demands, the development of genetic material and farming equipment and the availability of relatively cheap feed has encouraged farmers to specialise. As a consequence animal numbers and farm sizes have increased and intensive livestock farming began.

Animal welfare issues and developments in these have been respected throughout this work, although they have not been a primary driving force. In addition to the existing EU-legislation, the discussion about animal welfare will be continued. Some of the Member States have already different regulations concerning animal welfare and promote housing system requirements exceeding animal welfare regulations.

Poultry

Worldwide, Europe is the second largest producer of hen eggs with about 19 % of the world total and it is expected that this production will not change significantly in the coming years. Eggs for human consumption are produced in all Member States. The largest producer of eggs in the EU is France (17 % of egg production) followed by Germany (16 %), Italy and Spain (both 14 %) closely followed by the Netherlands (13 %). Of the exporting Member States the Netherlands is the largest exporter with 65 % of its production exported, followed by France, Italy and Spain, while in Germany consumption is higher than production. Most of the EU-produced consumption eggs (about 95 %) are consumed within the European community itself.

The majority of laying hens in the EU are kept in cages, although particularly in Northern Europe, non-cage egg production has gained in popularity over the past ten years. For example, the United Kingdom, France, Austria, Sweden, Denmark and the Netherlands have all increased the proportion of eggs produced in systems such as barn, semi-intensive, free range and deep litter. Deep litter is the most popular non-cage system in all Member States, except for France, Ireland and the United Kingdom, where semi-intensive systems and free range are preferred.

The number of layers kept on one farm varies considerably between a few thousand and up to several hundred thousand. Only a relatively small number of farms per Member State are expected to be under the scope of the IPPC Directive.

The biggest producer of poultry meat in the EU-15 (year 2000) is France (26 % of EU-15 poultry meat production), followed by United Kingdom (17 %), Italy (12 %) and Spain (11 %). Some countries are clearly export-orientated, such as the Netherlands, where 63 % of production is not consumed within the country, and Denmark, France and Belgium where 51 %, 51 % and 31 % of production are not consumed within the country of production. On the other hand, some countries such as Germany, Greece and Austria have consumption higher than production; in those countries, 41 %, 21 % and 23 % of the total consumption is imported from other countries.

Production of poultry meat has been increasing since 1991. The largest EU producers (France, UK, Italy and Spain) all show an increase in their poultry meat production.

Broilers are generally not housed in cages, although cage systems exist. The majority of poultry meat production is based on an all-in all-out system applying littered floors. Broiler farms with over 40000 bird places, thus falling under the scope of the IPPC Directive, are quite common in Europe.

Pigs

The EU-15 accounts for approximately 20 % of world pork production, which is indicated by slaughtered carcass weight. The major producer of pork is Germany (20 %), followed by Spain (17 %), France (13 %), Denmark (11 %) and the Netherlands (11 %). Together they produce more than 70 % of the EU-15 indigenous production. The EU-15 is a net exporter of pork, importing only a very small amount. However, not every major producer is a net exporter; Germany, for example, imported about twice as much as it exported in 1999.

In the EU-15, pig production increased between 1997 and 1999 with production almost 25 % higher in the last quarter of 1998 than in the second quarter of 1997. The total number of pigs in December 1998 was 125.4 million, which was a 5.4 % increase compared with 1997. In 1999 production slowed down and figures for December 2000 again revealed a slight decline.

Pig farms vary considerably in size. Across the EU-15, 67 % of sows are in units of more than 100 sows. In Belgium, Denmark, France, Ireland, Italy, the Netherlands and the United Kingdom this figure is over 70 %. In Austria, Finland and Portugal smaller sow units are predominant.

The majority of pigs for fattening (81 %) are reared on units of 200 pigs or more, with 63 % of them on units of more than 400 pigs. 31 % of fattening pigs are reared on holdings of more than 1000 pigs. The industry in Italy, United Kingdom and Ireland is characterised by units of more than 1000 fattening pigs. Germany, Spain, France and the Netherlands have significant proportions of pigs in units of between 50 and 400 fattening pigs. From these numbers it is obvious that only a relatively small number of farms will fall under the scope of the IPPC Directive.

In the assessment of consumption and emission levels of pig farming it is important to know the production system applied. Growing and finishing typically aim for a slaughter weight of 90 - 95 kg (UK), 100 – 110 kg (other) or 150 – 170 kg (Italy), these weights being reached over different periods of time.

Environmental impact of the industry

In intensive livestock the key environmental aspect is that the animals metabolise feed and excrete nearly all the nutrients via manure. In the production of pigs for slaughter the process of nitrogen consumption, utilisation and losses is well understood and is shown in Figure 1. Unfortunately such a figure is not available for poultry.

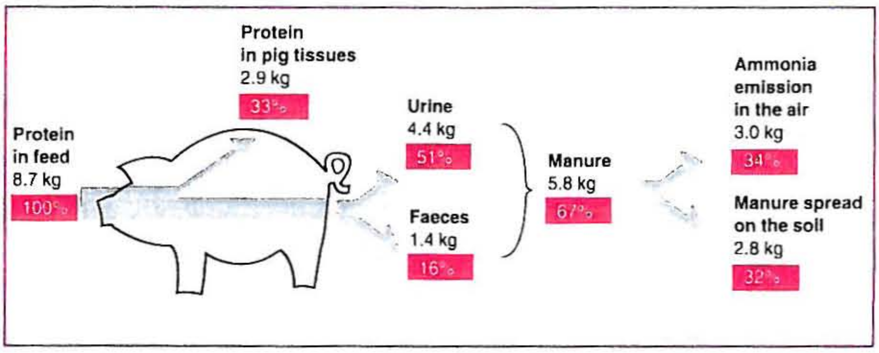


Figure 1: Consumption, utilisation and losses of protein in the production of a pig of 108 kg

Intensive livestock farming coincides with high animal densities and this density can be considered as a rough indicator of the amount of animal manure produced by the livestock. A high density might suggest that the mineral supply available from the animal manure might exceed the requirements of the agricultural area for growing crops or maintaining grassland.

In most countries pig production is concentrated in certain regions, for example in the Netherlands production is concentrated in the southern provinces, in Belgium it is strongly concentrated in West Flanders. In France intensive pig production is concentrated in Brittany and in Germany pig production is concentrated in the northwest. Italy has concentrations of pig production in the Po valley; in Spain this is in Cataluña and Galicia and in Portugal pig production is concentrated in the north. The highest densities are reported to be in the Netherlands, Belgium and Denmark.

Data on the concentration of livestock production at a regional level are considered to be a good indication of whether a region might have potential environmental problems. This is clearly illustrated by Figure 2 which shows problems such as: acidification (NH_3, SO_2, NO_x), eutrophication (N, P), local disturbance (odour, noise) and diffuse spreading of heavy metals and pesticides.

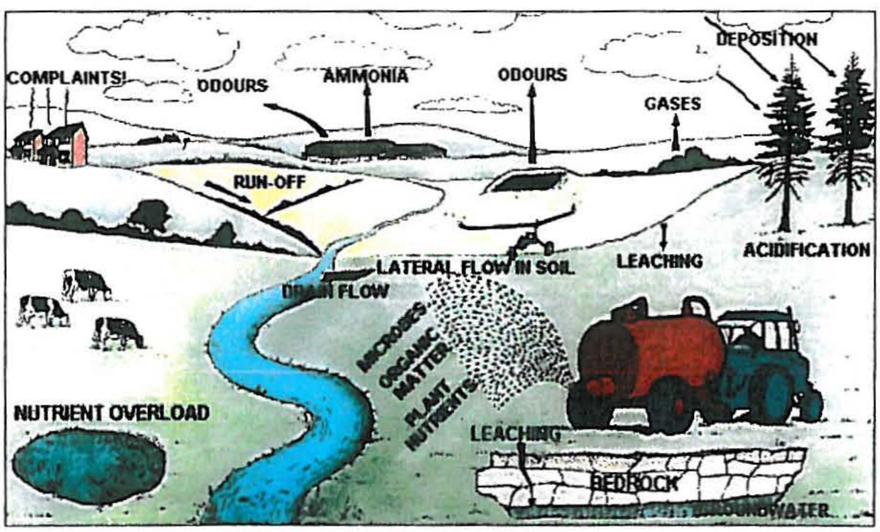


Figure 2: Illustration of environmental aspects related to intensive livestock farming

Applied techniques and BAT on intensive livestock farming

Generally, the activities that can be found on intensive livestock farms are:

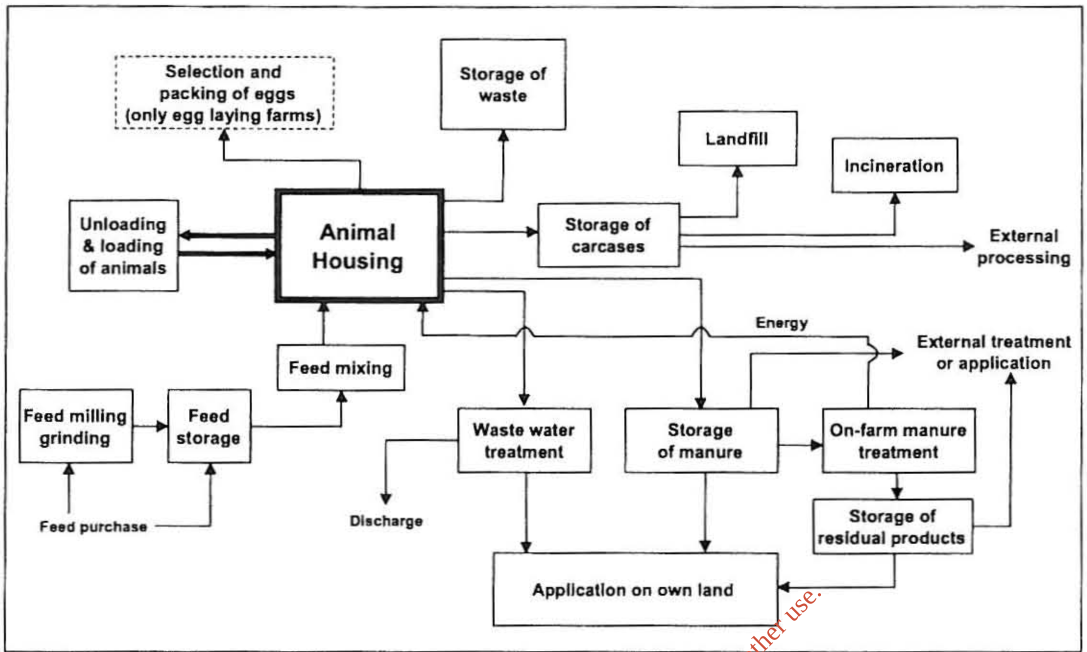


Figure 3: Illustration of environmental aspects related to intensive livestock farming

The central environmental issue in intensive livestock farming is manure. This is reflected in the order in which on-farm activities are presented in Chapters 4 and 5 in this document, starting with good agricultural practice, followed by feeding strategies to influence quality and composition of the manure, methods of removing the manure from the housing system, the storage and treatment of manure and finally the landspreading of manure. Other environmental issues such as waste, energy, water and waste water, and noise are also addressed, although in lesser detail.

Ammonia has been given most attention as the key air pollutant as it is emitted in the highest quantities. Nearly all the information on the reduction of emissions from animal housing reported on the emission reduction of ammonia. It is assumed that techniques reducing the emissions of ammonia will reduce emissions of the other gaseous substances as well. Other environmental impacts relate to nitrogen and phosphorus emissions to soil, surface water and groundwater, and result from the application of manure to land. Measures to decrease these emissions are not limited to how to store, treat or apply the manure once it arises, but comprise measures throughout a whole chain of events, including steps to minimise the production of manure.

In the paragraphs below the applied techniques and the conclusions on BAT are summarised for poultry and pigs.

Good agricultural practice in the intensive rearing of pigs and poultry

Good agricultural practice is an essential part of BAT. Although it is difficult to quantify environmental benefits in terms of emission reductions or reductions in the use of energy and water, it is clear that conscientious farm management will contribute to an improved environmental performance of an intensive poultry or pig farm. For improving the general environmental performance of an intensive livestock farm, BAT is to do all of the following:

- identify and implement education and training programmes for farm staff
- keep records of water and energy usage, amounts of livestock feed, waste arising and field applications of inorganic fertiliser and manure
- have an emergency procedure to deal with unplanned emissions and incidents
- implement a repair and maintenance programme to ensure that structures and equipment are in good working order and that facilities are kept clean
- plan activities at the site properly, such as the delivery of materials and the removal of products and waste, and
- plan the application of manure to land properly.

Feeding strategies for poultry and pigs

The composition of poultry feed varies considerably not just between installations but also between MSs. This is because it is a mixture of different ingredients, such as cereals, seeds, soya beans, and bulbs, tubers, roots or root crops and products of animal origin (e.g. fish meal, meat and bone meal and milk products). The main ingredients for pigs are cereals and soya.

The efficient feeding of animals aims to supply the required amount of net energy, essential amino acids, minerals, trace elements and vitamins for growth, fattening or reproduction. Pigs feed formulation is a complex matter and factors such as, live weight and the stage of reproduction, influence the composition of feed. Liquid feed is the most commonly applied, but dry feed or mixtures are also applied.

Apart from formulating the feed to closely match the requirements of the birds and the pigs, different types of feeding are also given during production cycles. See Table 1 for the different categories and the number of feeds that are most commonly applied and that are BAT.

An applied technique to reduce the excretion of nutrients (N and P) in manure, for pigs and poultry, is 'nutritional management'. Nutritional management aims to match feeds more closely to animal requirements at various production stages, thus reducing the amount of nitrogen waste rising from undigested or catabolised nitrogen, and which is subsequently eliminated through urine. Feeding measures include phase-feeding, formulating diets based on digestible/available nutrients, using low protein amino acid-supplemented diets and using low phosphorus phytase-supplemented diets or diets with highly digestible inorganic feed phosphates. Furthermore the use of certain feed additives, such as enzymes, may increase the feed efficiency thereby improving the nutrient retention and hence reducing the amount of nutrient left over in the manure.

For pigs a crude protein reduction of 2 to 3 % (20 to 30 g/kg of feed) can be achieved depending on the breed/genotype and the actual starting point, for poultry this is 1 to 2 % (10 to 20 g/kg of feed). The resulting range of dietary crude protein contents concluded to be BAT is reported in Table 1. The values in the table are only indicative, because they, amongst others, depend on the energy content of the feed. Therefore levels may need to be adapted to local conditions. Research on further applied nutrition is currently being carried out in a number of Member States and may support possible further reductions in the future, depending on the effects of changes in genotypes.

As far as phosphorus is concerned, a basis for BAT is to feed animals (poultry and pigs) with successive diets (phase-feeding) with lower total phosphorus contents. In these diets, highly digestible inorganic feed phosphates and/or phytase must be used in order to guarantee a sufficient supply of digestible phosphorus.

For poultry a total phosphorus reduction of 0.05 to 0.1 % (0.5 to 1 g/kg of feed) can be achieved depending on the breed/genotypes, the use of feed raw materials and the actual starting point by the application of highly digestible inorganic feed phosphates and/or phytase in the feed. For pigs this reduction is 0.03 to 0.07 % (0.3 to 0.7 g/kg of feed). The resulting range of dietary total phosphorus contents is reported in Table 1. As for the pigs situation, the BAT associated values in the table are only indicative, because they, amongst others, depend on the energy content of the feed. Therefore levels may need to be adapted to local conditions. Further applied nutrition research is currently being carried out in a number of Member States and may support further possible reductions in the future, depending on the effects of changes in genotypes.

Species	Phases	Crude protein content (% in feed) [1)]	Total phosphorus content (% in feed) [2)]	Remark
Broiler	starter	20 – 22	0.65 – 0.75	1) With adequately balanced and optimal digestible amino acid supply and 2) With adequate digestible phosphorus by using e.g. highly digestible inorganic feed phosphates and/or phytase
	grower	19 – 21	0.60 – 0.70	
	finisher	18 – 20	0.57 – 0.67	
Turkey	<4 weeks	24 – 27	1.00 – 1.10	
	5 – 8 weeks	22 – 24	0.95 – 1.05	
	9 – 12 weeks	19 – 21	0.85 – 0.95	
	13+ weeks	16 – 19	0.80 – 0.90	
	16+ weeks	14 – 17	0.75 – 0.85	
Layer	18 – 40 weeks	15.5 – 16.5	0.45 – 0.55	
	40+ weeks	14.5 – 15.5	0.41 – 0.51	
Weaner	<10 kg	19 – 21	0.75 – 0.85	
Piglet	<25 kg	17.5 – 19.5	0.60 – 0.70	
Fattening pig	25 – 50 kg	15 – 17	0.45 – 0.55	
	50 – 110 kg	14 – 15	0.38 – 0.49	
Sow	gestation	13 – 15	0.43 – 0.51	
	lactation	16 – 17	0.57 – 0.65	

Table 1: Indicative crude protein levels in BAT-feeds for poultry and pigs

Housing systems for poultry; laying hens

Most laying hens are still kept in cages. The conventional housing system is a battery with open manure storage under the cages, but nowadays most techniques are an improvement of this system. The principle behind the reduction of ammonia emissions from the cages is a frequent removal of the manure. Drying of manure also reduces the emissions by inhibiting the chemical reactions. The quicker the manure is dried the lower the emission of ammonia. A combination of frequent removal and forced drying of manure gives the highest reduction of ammonia emissions from the housing and also reduces emissions from the storage facilities, but at an associated energy cost. The cage systems commonly applied, and which are BAT are:

- a cage system with manure removal, at least twice a week, by way of manure belts to a closed storage
- vertical tiered cages with a manure belt and with forced air drying, where the manure is removed at least once a week to a covered storage
- vertical tiered cages with a manure belt and with whisk-forced air drying, where the manure is removed at least once a week to a covered storage
- vertical tiered cages with a manure belt and with improved forced air drying, where the manure is removed from the house at least once a week to a covered storage
- vertical tiered cages with a manure belt and with drying tunnel over the cages; the manure is removed to a covered storage after 24 – 36 hours.

The cage system with an aerated open manure storage (also known as a deep pit system) is a conditional BAT. In regions where a Mediterranean climate prevails, this system is BAT. In regions with much lower average temperatures, this technique can show a significantly higher ammonia emission and is not BAT unless a means of drying the manure in the pit is provided.

However, as a consequence of the requirements laid down by Directive 1999/74/EC on layer housing and animal welfare, the above-mentioned cage systems will be banned. This will prohibit the installation of any new conventional cage systems by 2003 and lead to a total ban on the use of such cage systems by 2012. However, in 2005 it will be decided whether the above-mentioned Directive needs to be reviewed. This decision depends on the results of several studies and on-going negotiations.

The banning of conventional cage systems will require farmers to use the so-called enriched cage or non-cage systems. Different techniques applying the enriched cage concept are currently under development but little information is yet available. However, these designs will form the only alternative cage system that will be allowed for new installations from 2003 onwards. Applied non-cage housing systems, which are concluded to be BAT, are:

- a deep litter system (with or without forced drying of the manure)
- a deep litter system with a perforated floor and forced drying of the manure
- an aviary system with or without range and/or outside scratching area.

The information in the main body of the BREF, on all the above mentioned housing systems, shows that improving the animal welfare would have a negative effect of limiting the achievable reduction of ammonia emissions from layer housing.

Housing systems for poultry; broilers

The traditional housing for intensive broiler production is a simple closed building construction of concrete or wood with natural light or windowless with a light system, thermally insulated and force-ventilated. Buildings are also used that are constructed with open sidewalls (windows with jalousie-type curtains); forced ventilation (negative pressure principle) is applied by way of fans and air inlet valves. The broilers are kept on litter (normally chopped straw, but wood shavings or shredded paper are also applied) spread over the entire house floor area. Manure is removed at the end of each growing period. Broilers are normally kept at a stocking density of 18 to 24 birds per m^2 and the houses can stock between 20000 and 40000 birds. New legislation on animal welfare is expected to limit the stocking density of broilers.

To reduce ammonia emissions from the housing wet litter must be avoided. For this reason a new housing technique (VEA-system) was designed where attention was paid to the insulation of the building, to the drinking system (to avoid spillage) and to the application of wood shavings/sawdust. However, emissions were shown to be equal to the traditional housing system. The decision on BAT was that BAT on housing systems for broilers is:

- the naturally ventilated house with a fully littered floor and equipped with non-leaking drinking systems
- the well-insulated fan ventilated house with a fully littered floor and equipped with non-leaking drinking systems (VEA-system).

Some newly developed systems have a forced drying system that blows air through a layer of litter and droppings. The reduction in ammonia emissions is considerable (83 – 94 % reductions compared to the traditional housing system), but they are expensive, show an increase in energy use and have high dust levels. However, when already in place they are concluded to be BAT. These techniques are:

- a perforated floor system with forced air drying system
- a tiered floor with forced air drying system
- a tiered cage system with removable cage sides and the forced drying of manure.

There is normally a system for heating the air in broiler houses. This can be the "combideck system", which heats the floor and the substances (such as litter) on top of it. The system consists of a heat pump, an underground storage facility made of tubes, and a layer of isolated hollow strips (intermediately spaced every 4 cm) 2 – 4 metres below the floor. The system uses two water cycles: one serving the house and the other acting as the underground storage. Both cycles are closed and connected through a heat pump. In the broiler house, the hollow strips are put in an insulated layer below the concrete floor (10 - 12 cm). Depending on the temperature of the water that flows through the strips, the floor and the litter will either be warmed up or cooled down.

This combideck system, also proposed as a technique to reduce energy, is a conditional BAT. It can be applied if local conditions allow, e.g. if soil conditions allow the installation of closed underground storages of the circulated water. The system is only applied in the Netherlands and in Germany, at a depth of 2 – 4 metres. It is not yet known if this system performs equally well in locations where the frosts are longer and harder and penetrate the soil or where the climate is much warmer and the cooling capacity of the soil might not be sufficient.

Housing systems for pigs; general remarks

A number of general points are made on pig housing which are followed by a detailed description of applied housing techniques and BAT on housings for mating and gestating sows, growers/finishers, farrowing sows and weaners.

Designs to reduce ammonia emissions to air from pig housing systems, as presented in Chapter 4, basically involve some or all of the following principles:

- reducing emitting manure surfaces
- removing the manure (slurry) from the pit to an external slurry store
- applying an additional treatment, such as aeration, to obtain flushing liquid
- cooling the manure surface
- using surfaces (for example, of slats and manure channels) which are smooth and easy to clean.

Concrete, iron and plastic are used in the construction of slatted floors. Generally speaking and given the same slat width, manure dropped on concrete slats takes longer to fall into the pit than when using iron or plastic slats, and this is associated with higher emissions of ammonia. It is worth noting that iron slats are not allowed in some Member States.

The frequent removal of manure by flushing with slurry may result in a peak in odour emissions with each flush. Flushing is normally done twice a day; once in the morning and once in the evening. These peaks in odour emissions can cause a nuisance to neighbours. Additionally treatment of the slurry also requires energy. These cross-media effects have been taken into account in defining BAT on the various housing designs.

With respect to litter (typically straw), it is expected that the use of litter in pig housing will increase throughout the Community due to a raised awareness of animal welfare. Litter may be applied in conjunction with (automatically-controlled) naturally ventilated housing systems, where litter would protect the animals from low temperatures, thus requiring less energy input for ventilation and heating. In systems where litter is used, the pen can be divided into a dunging area (without litter) and a littered solid floor area. It is reported that pigs do not always use these areas in the correct way, i.e. they dung in the littered area and/or use the slatted- or solid dunging area to lie on. However, the pen design can influence the behaviour of the pigs, although it is reported that in regions with a warm climate this might not be sufficient to prevent the pigs dunging and lying in the wrong areas. The argument for this is that in a full litter system the pigs do not have the possibility of cooling down by lying on an uncovered floor.

An integrated evaluation of litter use would include the extra costs for litter supply and mucking out, as well as the possible consequences on the emissions from storage of the manure and for the application onto land. The use of litter results in solid manure which increases the organic matter of the soils. In some circumstances therefore this type of manure is beneficial to soil quality; this is a very positive cross-media effect.

In Chapter 4 applied housing techniques for pigs are assessed on the ammonia emission reduction potential, N_2O and CH_4 emissions, cross-media effects (use of energy and water, odour, noise, dust), applicability, operability, animal welfare and cost; all compared against a specific reference system.

Housing systems for pigs; mating/gestating sows

Currently applied housing systems for mating/gestating sows are:

- fully-slatted floors, artificial ventilation and underlying deep collection pit (Note: this is the reference system)
- fully- or partly-slatted floors with a vacuum system underneath for frequent slurry removal
- fully- or partly-slatted floors with flush canals underneath the floor and where flushing is done with fresh slurry or with slurry that is aerated
- fully- or partly-slatted floors with flush gutters/tubes underneath and where flushing is done with fresh slurry or with slurry that is aerated
- partly-slatted floors with a reduced manure pit underneath
- partly-slatted floors with manure surface cooling fins
- partly-slatted floors with a manure scraper
- solid concrete floor with full litter
- solid concrete floor with straw and electronic feeders.

Currently mating and gestating sows can be housed either individually or in a group. However, EU legislation on pig welfare (91/630/EEC) provides minimum standards for the protection of pigs and will require sows and gilts to be kept in groups, from 4 weeks after service to 1 week before the expected time of farrowing, for new or rebuilt houses from 1 January 2003, and from 1 January 2013 for existing housing.

Group-housing systems require different feeding systems (e.g. electronic sow feeders) to individual housing systems, as well as a pen design that influences sow behaviour (i.e. the use of dunging- and lying areas). However, from an environmental point of view, the submitted data seems to indicate that group-housing systems have similar emission levels to individual housing systems, if similar emission reduction techniques are applied.

In the same EU legislation on pig welfare as mentioned above (Council Directive 2001/88/EC amending 91/630/EEC), requirements for flooring surfaces are included. For gilts and pregnant sows, a specified part of the floor area must be continuous solid floor of which a maximum of 15 % is reserved for drainage openings. These new provisions apply to all newly built or rebuilt holdings from 1 January 2003, and to all holdings from 1 January 2013. The effect of these new flooring arrangements on emissions compared to a typical existing fully slatted floor (which is the reference system) has not been investigated. The maximum 15 % void for drainage in the continuous solid floor area is less than the 20 % void for the concrete slatted floor area in the new provisions (a maximum 20 mm gap and a minimum slat width of 80 mm for sows and gilts). Therefore the overall effect is to reduce the void area.

In the assessment on BAT on housing systems, techniques are compared against the reference system used for the housing of mating and gestating sows, which is a deep pit under a fully-slatted floor with concrete slats. The slurry is removed at frequent or infrequent intervals. Artificial ventilation removes gaseous components emitted by the stored slurry manure. The system has been applied commonly throughout Europe. Regarding housing systems for mating/gestating sows, BAT is to have:

- fully- or partly-slatted floors with a vacuum system underneath for frequent slurry removal, or
- partly-slatted floors and a reduced manure pit.

It is generally accepted that concrete slats give more ammonia emissions than metal or plastic slats. However, for the BAT mentioned above no information was available on the effect of different slats on the emissions or costs.

New to build housing systems with a fully- or partly-slatted floor and flush gutters or tubes underneath and flushing is applied with non-aerated liquid are conditional BAT. In instances where the peak in odour, due to the flushing, is not expected to give nuisance to neighbours these techniques are BAT for new to build systems. In instances where this technique is already in place, it is BAT (without condition).

A housing system with manure surface cooling fins using a closed system with heating pumps performs well but is a very costly system. Therefore manure surface cooling fins are not BAT for new to build housing systems, but when it is already in place, it is BAT. In retrofit situations this technique can be economically viable and thus can be BAT as well, but this has to be decided on a case by case basis.

Partly-slatted floor systems with a manure scraper underneath generally perform well, but the operability is difficult. Therefore a manure scraper is not BAT for new to build housing systems, but it is BAT when the technique is already in place.

Fully- or partly-slatted floor systems and flushing gutters or tubes underneath with flushing applied with non-aerated liquid is, as already mentioned earlier, BAT when it is already in place. The same technique operated with aerated liquid is not BAT for new to build housing systems because of odour peaks, energy consumption and operability. However, in instances where this technique is already in place, it is BAT.

Split view:

One Member State supports the conclusions on BAT, but in their view the following techniques are also BAT in instances where the techniques are already in place and are also BAT when an extension (by means of a new building) is planned to operate with the same system (instead of two different systems):

- fully- or partly-slatted floors with flushing of a permanent slurry layer in channels underneath with non-aerated or aerated liquid.

These systems, often applied in this Member State, can achieve a higher ammonia emission reduction than those systems previously identified as BAT or conditional BAT. The argument then is that the high cost of retrofitting existing systems by any of these BATs is not justified. When an extension is added, for example by means of a new building, to a plant already adopting these systems, implementation of BAT or conditional BAT would reduce operability by making the operator use two different systems at the same farm. Therefore, the Member State considers these systems are BAT because of their good emission reduction capability, their operability and cost considerations.

On systems using litter very variable emission reduction potentials are reported to date, and further data must be acquired to allow better guidance on what is BAT for litter based systems. However, the TWG concluded that when litter is used, along with good practices such as having enough litter, changing the litter frequently, designing the pen floor suitably, and creating functional areas, then they cannot be excluded as BAT.

Housing systems for pigs; growers/finishers

Currently applied housing systems for growers/finishers are:

- fully-slatted floors, artificial ventilation and underlying deep collection pit (Note: this is the reference system)
- fully- or partly-slatted floors with a vacuum system underneath for frequent slurry removal
- fully- or partly-slatted floors with flush canals underneath and where flushing is done with fresh slurry or with slurry that is aerated
- fully- or partly-slatted floors with flush gutters/tubes underneath and where flushing is done with fresh slurry or with slurry that is aerated
- partly-slatted floors with a reduced manure pit underneath
- partly-slatted floors with manure surface cooling fins
- partly-slatted floors with a manure scraper

- partly-slatted floors with a central convex solid floor or an inclined solid floor at the front of the pen, a manure channel with slanted side walls and a sloped manure pit
- partly-slatted floors with a reduced manure pit, including slanted walls and a vacuum system
- partly-slatted floor with fast removal of slurry and littered external alley
- partly-slatted floor with a covered box
- solid concrete floor with full litter and outdoor climate
- solid concrete floor with a littered external alley and a straw flow system.

Growers/finishers are always housed in a group and most of the systems for the group housing of sows apply here as well. In the assessment on BAT on housing systems, techniques are compared against the reference system used for the housing of growers/finishers, which is a fully-slatted floor with a deep manure pit underneath and mechanical ventilation. On housing systems for growers/finishers, BAT is:

- a fully-slatted floor with a vacuum system for frequent removal, or
- a partly-slatted floor with a reduced manure pit, including slanted walls and a vacuum system, or
- a partly-slatted floor with a central, convex solid floor or an inclined solid floor at the front of the pen, a manure gutter with slanted sidewalls and a sloped manure pit.

It is generally accepted that concrete slats give more ammonia emissions than metal or plastic slats. However, the reported emission data show only a difference of 6 %, but costs are significantly higher. Metal slats are not allowed in every Member State, and they are not suitable for very heavy pigs.

New to build housing systems with a fully- or partly-slatted floor and flush gutters or tubes underneath and where flushing is applied with non-aerated liquid are conditional BAT. In instances where the peak in odour, due to the flushing, is not expected to give nuisance to neighbours these techniques are BAT for new to build systems. In instances where this technique is already in place, it is BAT (without condition).

A housing system with manure surface cooling fins using a closed system with heating pumps performs well but is a very costly system. Therefore manure surface cooling fins are not BAT for new to build housing systems, but when it is already in place, it is BAT. In retrofit situations this technique can be economically viable and thus can be BAT as well, but this has to be decided on a case by case basis. It has to be noted that energy efficiency can be lower in situations where the heat that arises from the cooling is not used, for example because there are no weaners to be kept warm.

Partly-slatted floor systems with a manure scraper underneath generally perform well, but the operability is difficult. Therefore a manure scraper is not BAT for new to build housing systems, but it is BAT when the technique is already in place.

Fully- or partly-slatted floor systems and flushing gutters or tubes underneath with flushing applied with non-aerated liquid is, as already mentioned earlier, BAT when it is already in place. The same technique operated with aerated liquid is not BAT for new to build housing systems because of odour peaks, energy consumption and operability. However, in instances where this technique is already in place, it is BAT.

Split view:

One Member State supports the conclusions on BAT, but for the same reason and using the same arguments as mentioned earlier on the housing for mating/gestating sows, in their view the following techniques are also BAT:

- a fully- or partly-slatted floor with flushing of a permanent slurry layer in channels underneath with non-aerated or aerated liquid.

On systems using litter very variable emission reduction potentials are reported to date, and further data must be acquired to allow better guidance on what is BAT for litter based systems. However, the TWG concluded that when litter is used, along with good practices such as having enough litter, changing the litter frequently, designing the pen floor suitably, and creating functional areas, then they cannot be excluded as BAT. The following system is an example of what may be BAT:

- solid concrete floors with a littered external alley and a straw flow system.

Housing systems for pigs; farrowing sows

Currently applied housing systems for farrowing sows are:

- crates with fully-slatted floors and underlying deep collection pit (which is the reference)
- crates with fully-slatted floors and a board on a slope underneath
- crates with fully-slatted floors and a combination of a water and manure channel underneath
- crates with fully-slatted floors and a flushing system with manure gutters underneath
- crates with fully-slatted floors and manure pan underneath
- crates with fully-slatted floors and manure surface cooling fins
- crates with partly-slatted floors
- crates with partly-slatted floors and a manure scraper

Farrowing sows in Europe are generally housed in crates with iron and/or plastic slatted floors. In the majority of the houses sows are confined in their movement, with piglets walking around freely. Most houses have controlled ventilation and often a heated area for the piglets during the first few days. This system with a deep manure pit underneath is the reference system.

The difference between fully- and partly-slatted floors is not so distinct in the case of farrowing sows, where the sow is confined in its movement. In both cases dunging takes place in the same slatted area. Reduction techniques therefore focus predominantly on alterations to the manure pit.

BAT is a crate with a fully-slatted iron or plastic floor and with a:

- combination of a water and manure channel, or
- flushing system with manure gutters, or
- manure pan underneath.

A housing system with manure surface cooling fins using a closed system with heating pumps performs well but is a very costly system. Therefore manure surface cooling fins are not BAT for new to build housing systems, but when it is already in place, it is BAT. In retrofit situations this technique can be economically viable and thus can be BAT as well, but this has to be decided on a case by case basis.

Crates with a partly-slatted floor and a manure scraper underneath generally perform well, but the operability is difficult. Therefore a manure scraper is not BAT for new to build housing systems, but it is BAT when the technique is already in place.

For new installations the following techniques are <u>not</u> BAT:

- crates with a partly-slatted floor and a reduced manure pit, and
- crates with a fully-slatted floor and a board on a slope.

However, when these techniques are already in place it is BAT. It has to be noted that with the latter system flies can easily develop if no control measures are undertaken.

Data must be acquired to allow better guidance on what is BAT for litter based systems. However, the TWG concluded that when litter is used, along with good practices such as having enough litter, changing the litter frequently, and designing the pen floor suitably then they cannot be excluded as BAT.

Housing systems for pigs; weaners

Currently applied housing systems for weaners are:

- pens or flatdecks with fully-slatted floors and an underlying deep collection pit (reference)
- pens or flatdecks with fully- or partly-slatted floors and a vacuum system for frequent slurry removal
- pens or flatdecks with fully-slatted floors and a concrete sloped floor to separate faeces and urine
- pens or flatdecks with fully-slatted floors and a manure pit with scraper
- pens or flatdecks with fully-slatted floors and flush gutters/tubes underneath, where flushing is done with fresh slurry or with slurry that is aerated
- pens with partly-slatted floors; the two-climate system
- pens with partly-slatted floors and a sloped or convex solid floor
- pens with partly-slatted floors and a shallow manure pit and a channel for spoiled drinking water
- pens with partly-slatted floors with triangular iron slats and manure channel with gutters
- pens with partly-slatted floors and manure scraper
- pens with partly-slatted floors with triangular iron slats and a manure channel with sloped side wall(s)
- pens with partly-slatted floors and manure surface cooling fins
- partly-slatted floors with triangular slats and a covered box
- solid concrete floors with straw and natural ventilation.

Weaners are housed in a group in pens or flatdecks. In principle, manure removal is the same for a pen as for a flatdeck (raised pen) design. The reference system is a pen or flatdeck with a fully-slatted floor made of plastic or metal slats and a deep manure pit.

It is assumed, that in principle, reduction measures applicable to conventional weaner pens can also be applied to the flatdeck, but experiences with such a change have not been reported.

BAT is a pen:

- or flatdeck with a fully-slatted- or partly-slatted floor with a vacuum system for frequent slurry removal, or
- or flatdeck with a fully-slatted floor beneath which there is a concrete sloped floor to separate faeces and urine, or
- with a partly-slatted floor (two-climate system), or
- with a partly-slatted iron or plastic floor and a sloped or convex solid floor, or
- with a partly-slatted floor with metal or plastic slats and a shallow manure pit and channel for spoiled drinking water, or
- with a partly-slatted floor with triangular iron slats and a manure channel with sloped side walls.

New to build housing systems with a fully-slatted floor and flush gutters or tubes underneath and where flushing is applied with non-aerated liquid are conditional BAT. In instances where the peak in odour, due to the flushing, is not expected to give nuisance to neighbours these techniques are BAT for new to build systems. In instances where this technique is already in place, it is BAT (without condition).

A housing system with manure surface cooling fins using a closed system with heating pumps performs well but is a very costly system. Therefore manure surface cooling fins are not BAT for new to build housing systems, but when it is already in place, it is BAT. In retrofit situations this technique can be economically viable and thus can be BAT as well, but this has to be decided on a case by case basis.

Fully-slatted and partly-slatted floor systems with a manure scraper generally perform well, but the operability is difficult. Therefore a manure scraper is not BAT for new to build housing systems, but it is BAT when the technique is already in place.

Weaners are also kept on solid concrete floors with part- or full litter. No ammonia emission data is reported for these systems. However, the TWG concluded that when litter is used, along with good practices such as, having enough litter, changing the litter frequently, and designing the pen floor suitably, then they cannot be excluded as BAT.

The following system is an example of what is BAT:

- a natural ventilated pen with a fully littered floor.

Water for pigs and poultry

In the rearing of pigs and poultry water is used for cleaning activities and for watering the animals. Reduction of the animals' water consumption is not considered to be practical. It will vary in accordance with their diet and, although some production strategies include restricted water access, permanent access to water is generally considered to be an obligation.

In principle three types of animal drinking systems are applied: low capacity nipple drinkers or high capacity drinkers with a drip-cup, water troughs and round drinkers for poultry, and for pigs these are: nipple drinkers in a trough or cup, water troughs and biting nipples. All of these have some advantages and some disadvantages. However, there is not enough data available to come to a BAT conclusion.

On activities where water is used, it is BAT to reduce water use by doing all of the following:

- cleaning animal housing and equipment with high-pressure cleaners after each production cycle or each batch. For pig housing, typically wash-down water enters the slurry system and therefore it is important to find a balance between cleanliness and using as little water as possible. In poultry housing it is also important to find the balance between cleanliness and using as little water as possible
- carry out a regular calibration of the drinking-water installation to avoid spill
- keeping record of water use through metering of consumption, and
- detecting and repairing leakages.

Energy for pigs and poultry

In the rearing of pigs and poultry, the information on the use of energy focuses on heating and ventilating the housing systems.

BAT for pigs and poultry is to reduce energy use by application of good farming practice starting with animal housing design and by adequate operation and maintenance of the housing and the equipment.

There are many actions that can be taken as part of the daily routine to reduce the amount of energy required for heating and ventilation. Many of these points are mentioned in the main body of the document. Some specific BAT measures are mentioned below:

BAT for poultry housing is to reduce energy use by doing all of the following:

- insulating buildings in regions with low ambient temperatures (U-value 0.4 $W/m^2/°C$ or better)
- optimising the design of the ventilation system in each house to provide good temperature control and to achieve minimum ventilation rates in winter
- avoiding resistance in ventilation systems through frequent inspection and cleaning of ducts and fans, and
- applying low energy lighting.

BAT for pig housing is to reduce energy use by doing all of the following:

- applying natural ventilation where possible; this needs proper design of the building and of the pens (i.e. microclimate in the pens) and spatial planning with respect to the prevailing wind directions to enhance the airflow; this applies only to new housing
- for mechanically ventilated houses: optimising the design of the ventilation system in each house to provide good temperature control and to achieve minimum ventilation rates in winter
- for mechanically ventilated houses: avoiding resistance in ventilation systems through frequent inspection and cleaning of ducts and fans, and
- applying low energy lighting.

Storage of manure from pigs and poultry

The Nitrates Directive lays down minimum provisions on storage of manure in general with the aim of providing all waters a general level of protection against pollution, and additional provisions on storage of manure in designated Nitrate Vulnerable Zones. Not all provisions in this Directive are addressed in this document because of a lack of data, but where they are addressed, the TWG agreed that BAT for slurry storage tanks, solid manure heaps or slurry lagoons is equally valid inside and outside these designated Nitrate Vulnerable Zones.

BAT is to design storage facilities for pig and poultry manure with sufficient capacity until further treatment or application to land can be carried out. The required capacity depends on the climate and the periods in which application to land is not possible. For pig manure, for example, the capacity can differ from the manure that is produced on a farm over a 4 – 5 month period in Mediterranean climate, a 7 – 8 month period in the Atlantic or continental conditions, to a 9 – 12 month period in boreal areas. For poultry manure the required capacity depends on the climate and the periods in which application to land is not possible

For a stack of pig manure that is always situated on the same place, either on the installation or in the field, BAT is to:

- apply a concrete floor, with a collection system and a tank for run-off liquid, and
- locate any new to build manure storage areas where they are least likely to cause annoyance to sensitive receptors for odour, taking into account the distance to receptors and the prevailing wind direction.

If poultry manure needs to be stored, BAT is to store dried poultry manure in a barn with an impermeable floor, and with sufficient ventilation.

For a temporary stack of pig or poultry manure in the field, BAT is to position the manure heap away from sensitive receptors such as, neighbours, and watercourses (including field drains) that liquid run-off might enter.

BAT on the storage of pig slurry in a concrete or steel tank comprises all of the following:

- a stable tank able to withstand likely mechanical, thermal and chemical influences
- the base and walls of the tank are impermeable and protected against corrosion
- the store is emptied regularly for inspection and maintenance, preferably every year
- double valves are used on any valved outlet from the store
- the slurry is stirred only just before emptying the tank for, e.g., application on land.

It is BAT to cover slurry tanks using one of the following options:

- a rigid lid, roof or tent structure, or
- a floating cover, such as chopped straw, natural crust, canvas, foil, peat, light expanded clay aggregate (LECA) or expanded polystyrene (EPS).

All of these types of covers are applied but have their technical and operational limitations. This means that the decision on what type of cover is preferred can only by taken on a case by case basis.

A lagoon used for storing slurry is equally as viable as a slurry tank, providing it has impermeable base and walls (sufficient clay content or lined with plastic) in combination with leakage detection and provisions for a cover.

It is BAT to cover lagoons where slurry is stored using one of the following options:

- a plastic cover, or
- a floating cover, such as chopped straw, LECA or natural crust.

All these types of covers are applied but have their technical and operational limitations. This means that the decision on what type of cover is preferred can only by taken on a case by case basis. In some situations it might be very costly, or technically not even possible to install a cover to an existing lagoon. The cost for installing a cover for very large lagoons or lagoons that have unusual shapes can be high. It might technically be impossible to install a cover when, for example, embankment profiles are not suitable to attach the cover to.

On-farm treatment of manure from pigs and poultry

Manure treatment prior to or instead of land spreading may be performed for the following reasons:

1. to recover the residual energy (biogas) in the manure
2. to reduce odour emissions during storage and/or land spreading
3. to decrease the nitrogen content of the manure, with the aim of preventing possible ground and surface water pollution as a result of land spreading and to reduce odour
4. to allow easy and safe transportation of the manure to distant regions or when it has to be applied in other processes.

A number of manure treatment systems is applied, although the majority of farms in the EU are able to manage manure without recourse to the techniques listed below. Besides treatment on-farm, pig and poultry manure may also be (further) treated off-site in industrial installations such as, poultry litter combustion, composting or drying. The assessment of off-site treatment is outside the scope of this BREF.

Applied techniques for the on-farm treatment of pig and or poultry manure are:

- mechanical separation
- aeration of liquid manure
- biological treatment of pig slurry
- composting of solid manure
- composting of poultry manure with pine bark
- anaerobic treatment of manure
- anaerobic lagoons
- evaporation and drying of pig slurry
- incineration of broiler manure
- applying additives to manure

In general, on-farm processing of manure is BAT only under certain conditions (i.e. is a conditional BAT). The conditions of on-farm manure processing that determine if a technique is BAT relate to conditions such as the availability of land, local nutrient excess or demand, technical assistance, marketing possibilities for green energy, and local regulations.

The following Table 2 gives some examples on the conditions for BAT for pig manure processing. The list is not exhaustive and other techniques may also be BAT under certain conditions. It is also possible that the chosen techniques are also BAT under other conditions.

Under the following conditions	an example of what is BAT:
• the farm is situated in an area with nutrient surplus but with sufficient land in the vicinity of the farm to spread the liquid fraction (with decreased nutrient content), and • the solid fraction can be spread on remote areas with a nutrient demand or can be applied in other processes	mechanical separation of pig slurry using a closed system (e.g. centrifuge or press-auger) to minimise the ammonia emissions (Section 4.9.1)
• the farm is situated in an area with nutrient surplus but with sufficient land in the vicinity of farm to spread treated liquid fraction, and • the solid fraction can be spread on remote areas with a nutrient demand, and • the farmer gets technical assistance for running the aerobic treatment installation properly	mechanical separation of pig slurry using a closed system (e.g. centrifuge or press-auger) to minimise the ammonia emissions, followed by aerobic treatment of the liquid fraction (Section 4.9.3.) and where the aerobic treatment is well-controlled so that ammonia and N_2O production are minimised
• there is a market for green energy, and • local regulations allow co-fermentation of (other) organic waste products and land spreading of digested products	anaerobic treatment of manure in a biogas installation (Section 4.9.6.)

Table 2: Examples of conditional BAT on on-farm pig manure processing

An example of a conditional BAT on poultry manure processing is:

- applying an external drying tunnel with perforated manure belts, when the housing system for layers does not incorporate a manure drying system or another technique for reducing ammonia emissions.

Landspreading of manure from pigs and poultry

General

The Nitrate Directive lays down minimum provisions on the application of manure to land with the aim of providing all waters a general level of protection against pollution from nitrogen compounds, and additional provisions for applying manure to land in designated vulnerable zones. Not all provisions in this Directive are addressed in this document because of a lack of data, but when they are addressed, the TWG agreed that BAT on landspreading is equally valid inside and outside these designated vulnerable zones.

There are different stages in the process, from pre-production of the manure, to post-production and finally spreading on land, where emissions can be reduced and/or controlled. The different techniques that are BAT and that can be applied at the different stages in the process are listed below. However, the principle of BAT is based on doing all the following four actions:

- applying nutritional measures
- balancing the manure that is going to be spread with the available land and crop requirements and – if applied – with other fertilisers
- managing the landspreading of manure, and
- only using the techniques that are BAT for the spreading of manure on land and – if applicable – finishing off.

BAT is to minimise emissions from manure to soil and groundwater by balancing the amount of manure with the foreseeable requirements of the crop (nitrogen and phosphorus, and the mineral supply to the crop from the soil and from fertilisation). Different tools are available to balance the total nutrient uptake by soil and vegetation against the total nutrient output of the manure, such as a soil nutrient balance or by rating the number of animals to the available land.

BAT is to take into account the characteristics of the land concerned when applying manure; in particular soil conditions, soil type and slope, climatic conditions, rainfall and irrigation, land use and agricultural practices, including crop rotation systems. BAT is to reduce pollution of water by doing in particular all of the following:

- not applying manure to land when the field is:
  - water-saturated
  - flooded
  - frozen
  - snow covered
- not applying manure to steeply sloping fields
- not applying manure adjacent to any watercourse (leaving an untreated strip of land), and
- spreading the manure as close as possible before maximum crop growth and nutrient uptake occur.

BAT is managing the landspreading of manure to reduce odour nuisance where neighbours are likely to be affected, by doing in particular all of the following:

- spreading during the day when people are less likely to be at home and avoiding weekends and public holidays, and
- paying attention to wind direction in relation to neighbouring houses.

Manure can be treated to minimise odour emissions which can then allow more flexibility for identifying suitable sites and weather conditions for land application.

Pig manure

The emissions of ammonia to air caused by the landspreading can be reduced through the selection of the right equipment. The reference technique is a conventional broadcast spreader, not followed by fast incorporation. Generally, landspreading techniques that reduce ammonia emissions also reduce odour emissions.

Each technique has its limitations and is not applicable in all circumstances and/or on all types of land. Techniques that inject slurry show the highest reduction, but techniques that spread slurry on top of the soil followed by incorporation shortly afterwards can achieve the same reduction. However, this requires extra labour and energy (costs) and only applies to arable land that can easily be cultivated. BAT conclusions are shown in Table 3. The achieved levels are very site-specific and serve only as an illustration of potential reductions.

The majority of the TWG agreed that either injection or bandspreading and incorporation (if the land can be easily cultivated) within 4 hours is BAT for applying slurry to arable land, however there was a split view on this conclusion (see below).

The TWG also agreed that, for applying slurry to land, the conventional broadcast spreader is not BAT. However, four Member States proposed that where broadcasting is operated with a low spread trajectory, and at low pressure (to create large droplets; thereby avoiding atomisation and wind drift), and slurry is incorporated into the soil as soon as possible (at least within 6 hours), or is applied to a growing arable crop, these combinations are BAT. The TWG has not reached consensus on this latter proposal.

No reduction techniques for the spreading of solid pig manure have been proposed. However, for reducing ammonia emissions from the landspreading of solid manure, incorporation is the important factor not the technique on how to spread. For grassland, incorporation is not possible.

Split views:

1. Two Member States do not support the conclusion that bandspreading of pig slurry on arable land followed by incorporation is BAT. In their view applying bandspreading on its own, which has an associated emission reduction of 30 – 40 % is BAT for spreading pig slurry on arable land. Their argument is that bandspreading already achieves a reasonable emission reduction and that the extra handling required for incorporation is difficult to organise and the extra reduction that can be achieved does not outweigh the extra costs.

2. Another split view on incorporation involves solid pig manure. Two Member States do not support the conclusion that incorporation of solid pig manure as soon as possible (at least within 12 hours), is BAT. In their view incorporation within 24 hours, which has an associated emission reduction of around 50 %, is BAT. Their argument is that the extra ammonia emission reduction that can be achieved does not outweigh the extra costs and difficulties involved in organising the logistics for incorporation within a shorter time.

Land use	BAT	Emission reduction	Type of manure	Applicability
grassland and land with crop height below 30 cm	trailing hose (bandspreading)	30 % this may be less if applied on grass height >10 cm	slurry	slope (<15 % for tankers; <25 % for umbilical systems); not for slurry that is viscous or has a high straw content, size and shape of the field are important
mainly grassland	trailing shoe (bandspreading)	40 %	slurry	slope (<20 % for tankers; <30 % for umbilical systems); not viscous slurry, size and shape of the field, grass less than 8 cm high
grassland	shallow injection (open slot)	60 %	slurry	slope <12 %, greater limitations for soil type and conditions, not viscous slurry
mainly grassland, arable land	deep injection (closed slot)	80 %	slurry	slope <12 %, greater limitations for soil type and conditions, not viscous slurry
arable land	bandspreading and incorporation within 4 hours	80 %	slurry	incorporation is only applicable for land that can be easily cultivated, in other situations BAT is bandspreading without incorporation
arable land	incorporation as soon as possible, but at least within 12 hours	within: 4 hrs: 80 % 12 hrs: 60 – 70 %	solid pig manure	only for land that can be easily cultivated

Table 3: BAT on landspreading equipment for pig manure

Poultry manure

Poultry manure has a high available nitrogen content and it is therefore important to get an even spread distribution and an accurate application rate. In this respect the rota-spreader type is poor. The rear-discharge spreader and dual-purpose spreader are much better. For wet poultry manure (<20 % dm) from caged systems, such as described in Section 4.5.1.4, broadcasting with a low trajectory at low pressure is the only applicable spreading technique. However, no conclusion about which spreading technique is BAT has been drawn. For reducing ammonia emissions from landspreading poultry manure, incorporation is the important factor not the technique on how to spread. For grassland, incorporation is not possible.

With research having started only relatively recently, many aspects are not known or quantified yet. Emissions are often diffuse and very difficult to measure. Models have been and still are being developed to allow accurate estimations of emissions to be made where direct measurements are not possible. Also, a number of aspects have only just been identified, where focus still is on emissions of ammonia (NH_3) and on emissions of N and P to soil, groundwater and surface water.

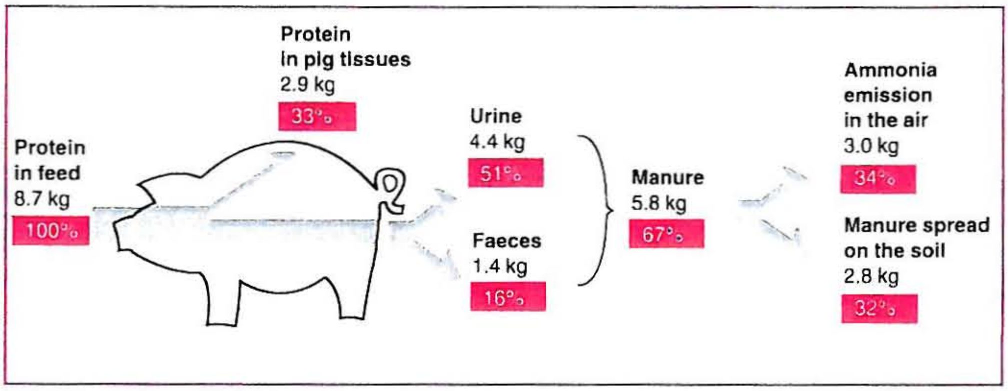


Figure 1.17: Consumption, utilisation and losses of protein in the production of a slaughter pig with a final live weight of 108 kg
[99, Ajinomoto Animal Nutrition, 2000]

1.4.1 Emissions to air

Air	Production system
Ammonia (NH_3)	Animal housing, storage of manure and landspreading of manure
Methane (CH_4)	Animal housing, storage of manure and manure treatment
Nitrous oxide (N_2O)	Animal housing, manure storage and landspreading
NO_x	Heaters in buildings and small combustion installations
Carbon dioxide (CO_2)	Animal housing, energy used for heating and transport on farm, burning of waste
Odour (e.g. H_2S)	Animal housing, storage of manure, landspreading of manure
Dust	Milling and grinding of feed, feed storage, housing of animals, solid manure storage and application
Dark smoke/CO	Burning of waste

Table 1.6: Emissions to air from intensive livestock production systems

N-related emissions

Most attention has been paid to the emission of ammonia from animal housing, as it is considered an important compound for the acidification of soils and water. A technical expert group is specifically working on the abatement of emissions of ammonia under the framework of the UNECE programme on long-range transboundary air pollution [9, UNECE, 1999].

Ammonia gas (NH_3) has a sharp and pungent odour and in higher concentrations can irritate the eyes, throat and mucous membranes in humans and farm animals. It slowly rises from the manure and spreads through the building and is eventually removed by the ventilation system. Factors such as the temperature, ventilation rate, humidity, stocking rate, litter quality and feed

Odour emissions especially from large poultry farms, can give rise to problems with neighbours. Emissions of odour are related to many different compounds such as, mercaptans, H_2S, skatole, thiocresol, thiophenol and ammonia [173, Spain, 2001].

Dust

Dust has not been reported as an important environmental issue in the surroundings of a farm, but it may cause some nuisance during dry or windy weather. Inside the animal house, dust is known under certain circumstances to be a contaminant that can affect both the respiration of the animals and the farmer, such as in broiler houses with high litter contents.

As an example, emissions of respirable dust (small dust particles) from deep litter systems (half litter, half slatted floor) and cage systems were estimated at 2.3 and 0.14 mg/h per hen respectively, based on measurements in commercial houses. Litter systems clearly give higher concentrations of respirable dust within the housing (1.25 and 0.07 mg/m^3 respectively). The differences can be explained in combination with the higher level of activity shown by hens in non-cage systems.

1.4.2 Emissions to soil, groundwater and surface water

Emissions from slurry storage facilities that contaminate soil and ground- or surface water occur because of inadequate facilities or operational failures and should be considered accidental rather than structural. Adequate equipment, frequent monitoring and proper operation can prevent leakage and spillage from slurry storage facilities.

Emissions to surface water can occur from a direct discharge of the waste water arising on a farm. Little quantified information is available on these emissions to surface water. Waste water arising from household and agricultural activities might also be mixed with slurry to be applied onto land, although mixing is not allowed in many MSs.

Waste water discharged directly into surface water can come from various sources but, normally only direct emissions from slurry treatment systems such as the lagoon systems are permitted. Emissions to surface water from these sources contain N and P, but increased levels of BOD may also occur; in particular in dirty water collected from the farmyard and from manure collection areas.

However, from all the sources, landspreading is the key activity responsible for the emissions of a number of components to soil, groundwater and surface water (and air, see Section 1.4.1). Although manure treatment techniques are available, the application of manure onto land is still the most favoured technique. Manure can be a good fertiliser, but where it is applied in excess to soil capacity and crop requirements it is a major agricultural source of emissions.

Soil and groundwater	Production system
Nitrogenous compounds	Landspreading and manure storage
Phosphorus	
K and Na	
(Heavy) metals	
Antibiotics	

Table 1.8: Main emissions to soil and groundwater from intensive livestock production systems

Most attention has been given to the emission of **nitrogen** and **phosphorus**, but other elements, such as potassium, nitrite, NH_4^+, micro-organisms, (heavy) metals, antibiotics, metabolics and other pharmaceuticals may end up in manure and their emissions may cause effects in the long run.

Many features of flat decks have evolved and been developed over the years. Now the term flat deck is often used to loosely describe almost all slurry-based weaner-housing systems, many of which bear little resemblance to the original concept. Some farmers have provided solid floored lying areas to help improve pig comfort and welfare. Underfloor heating has become a more common feature. Group sizes have tended to increase and the system is slowly evolving into a "nursery" room system with groups of up to around 100 pigs in a group in a partially solid-floored pen (around one third of the floor area solid) and no access passageways.

2.3.1.4 Housing of growers-finishers

From an average LW of 30 kg (25 – 35 kg) pigs are moved to separate sections to be grown and finished for slaughter. It is not uncommon to house growers (e.g. up to 60 kg) and finishers (from 60 kg onwards) in separate sections, but the housing facilities are very much the same. The housing systems used for growers-finishers can be compared with weaner houses (Section 2.3.1.3), except that most grower/finishers are kept in systems with little or no straw. Partly- and fully-slatted flooring are equally common, but there is a trend towards more fully-slatted flooring except in Belgium, Denmark, the Netherlands, and the UK.

The growing-finishing housing is a brick-built, open or closed, insulated construction for 100 to 200 pigs. It is usually divided into compartments for 10 – 15 pigs (small groups) or up to 24 pigs (large groups). The pens are arranged either with the aisle on one side or in a double row with the aisle in the centre. In the pens with a solid concrete floor, movable covers are used to cover the lying area, at least during the first stage of the growing period.

Feed distribution is usually automated and can be sensor-controlled. Liquid or dry feeding is applied ad-lib or restricted and multi-phase (adapted N and P content). Design of feeding troughs and drinkers depends on type of feeding.

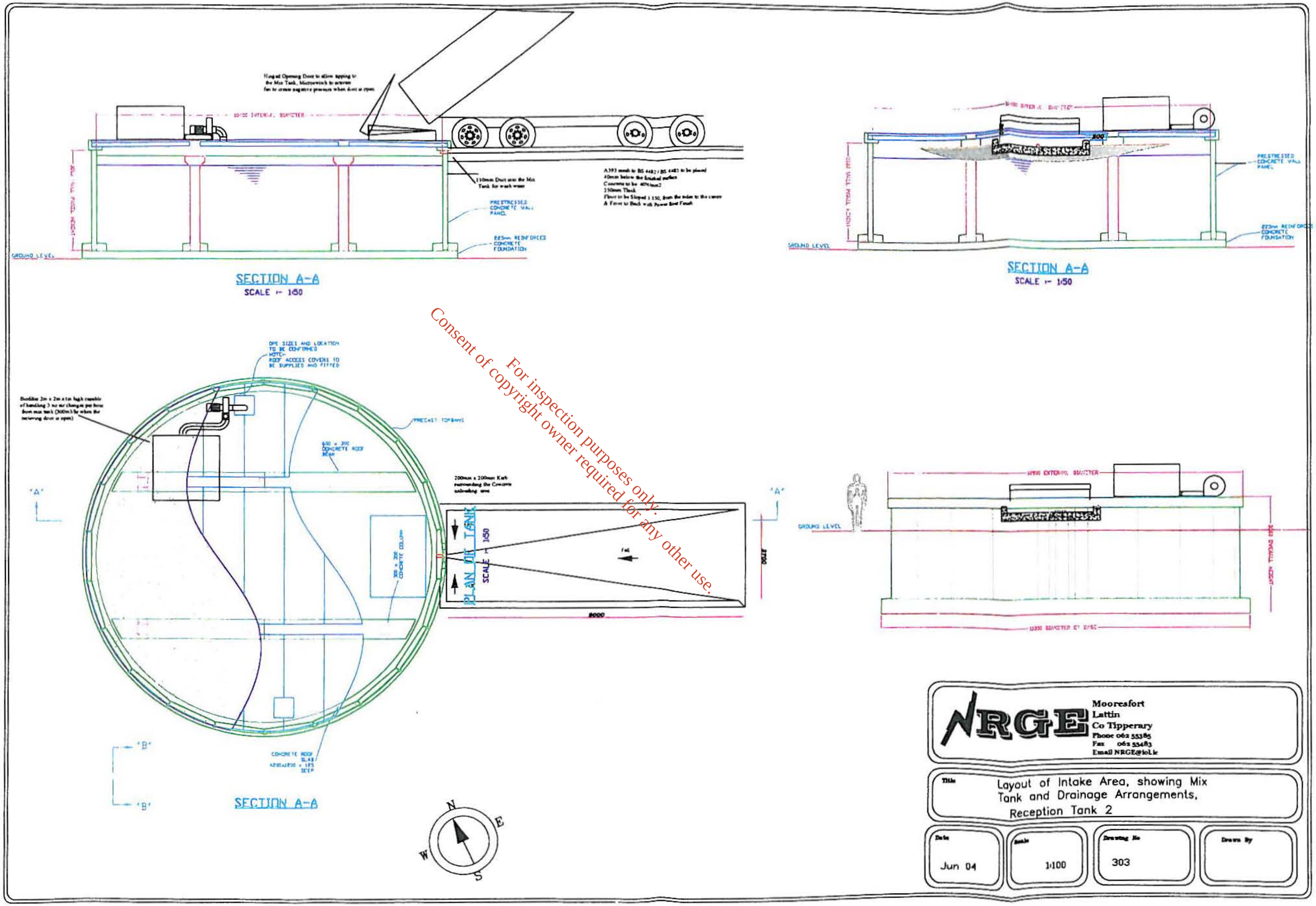
2.3.1.4.1 Housing of growers-finishers on a fully-slatted floor

This housing system is very common for small (10 – 15 pigs) and large groups (up to 24) of growers-finishers. It is applied in closed, thermally insulated housing with mechanical ventilation and in houses with natural ventilation. Windows allow daylight in and electrical light is used. Auxiliary heating is applied only when necessary, as the pigs' body-heat is usually capable of satisfying the heat requirement.

The pen is fully slatted and has no physical separation of the lying, eating and dunging areas. The slats are made of concrete or (plastic coated) iron. Manure is trodden through and urine mixes with the manure or runs off through urine/liquid manure channels. The slurry is collected in a manure pit under the fully-slatted floor. Depending on the depth of the pit, it may provide for an extended storage period (high ammonia levels in the house) or it is emptied frequently and the slurry is stored in a separate storage facility. A frequently applied system has the individual sections connected by a central drain, into which they are emptied by lifting a plug or a gate in the pipe.

ATTACHMENT NO. 5

DRAWING NO 303


SECTION A-A
SCALE 1:50
SECTION A-A
SCALE 1:50
PLAN OF TANK
SCALE 1:50
SECTION A-A
8000
2700
GROUND LEVEL
PRESTRESSED CONCRETE WALL PANEL
225mm REINFORCED CONCRETE FOUNDATION
PRECAST TOPBAND
Moorseforl
Lattin
Co Tipperary
Phone 062 55385
Fax 062 55483
Email NRGE@iol.ie
Title
Layout of Intake Area, showing Mix Tank and Drainage Arrangements, Reception Tank 2
Date
Jun 04
Scale
1:100
Drawing No
303
Drawn By