EPR 6.09 Sector Guidance Note

How to comply with your environmental permit for intensive farming

Appendix 10

Emission Reduction Plan

Version 3

January 2010

Environment Agency

Published by:

Environment Agency
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GEHO0110BRSG-E-E

First published January 2008
This version January 2010

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Record of changes:

Version	Date	Change
1	January 2008	Consultation Draft
2	March 2008	Final Version
3	January 2010	Guidance republished as an appendix to version 2 of How to comply with your environmental permit for intensive farming. Technical content of guidance is unchanged.

Emissions Reduction Plan

Scope of this document

This guidance is for those farmers who have improvement conditions which require a reduction in ammonia emissions from the farm or a reduction in their impact. For these farms, a plan to deliver emission reductions must be submitted to us within a specified timescale, and once the plan has been approved, it must be implemented within the timescales set out in the permit. This document sets out what must be covered in the plan. It does not specify what techniques must be used on a farm, since every site is different and the techniques chosen should be those that are most appropriate for the circumstances. It provides advice on where to go for further help or information.

The assessment on which the improvement conditions are based has been carried out using information provided by the farmer on the proposed operation and the appropriate conservation agency on the sensitivity of the wildlife site. Both we and the conservation agencies have checked our information as far as possible but you may wish to 'ground-truth' the data used in the assessment before undertaking additional work. For example, if the wildlife site is relatively large does the sensitive species occur within the area impacted by the farm? This may be considered as part of the emission reduction plan.

In checking the information used to estimate the required level of emissions reduction we have found that due to an error in units we have overestimated the impact of all farms by approximately 20%. Rather than issue variations to all the farmers concerned we have decided that the simplest way to deal with this issue is to take this into account as part of the emission reduction plans. Farms with an improvement condition requiring a reduction in emissions of less than 20% will no longer need to make this reduction provided there are no other changes to their operation. The farmer should write to us with this information as part of their emission reduction plan.

Where the impact of the farm is particularly significant, some farmers may have a second improvement condition requiring action to be taken within 12 months. Where this more rapid reduction is less than 20% the farmer should identify this issue in their emission reduction plan which needs to be submitted within 3 months of permit issue. The farmer would then need to only meet the longer term reductions required by 2011.

It is likely that assistance will be needed from someone who can run air quality dispersion models, and also someone who can advise on livestock buildings and structures for storing manures or slurries. The effectiveness of any of the techniques used to reduce ammonia emissions from the farm will need to be demonstrated. Approved techniques are set out in our guidance document

'How to Comply'[1], and in the Best Available Techniques Reference Document published by the European Commission[2]. Proposals to use a technique not set out in these documents will need to be supported by evidence to support its effectiveness either through the submission of published data or data that has at least been peer-reviewed. Some recent, relevant research is referenced in this document, but we recommend that a wider literature review is carried out in drawing up a plan.

The plan should include some or all of the following:

- Analysis of existing emission sources, management practices and site characteristics which may affect ammonia emissions.
- Impact assessment of the current operation.
- Identification and evaluation of potential techniques for achieving the required level of emissions.
- Demonstration that the chosen technique(s) will achieve the required level of environmental improvement
- Timescales and milestones for implementation

What are the emissions from the farm?

Through the permit application process, the emissions of ammonia from your farm will have been modelled. For existing farms permitted in 2007, we did the modelling on farmers behalf. For any new farms, the applying farmer will have employed consultants to complete this work.

Emissions are modelled using estimates for the amount of ammonia released from livestock housing and manure or slurry storage on the installation. Whether we or consultants have modelled the emissions, assumptions will have been made about how the business is operated to assign the most appropriate emission factors. If the permit is issued with improvement conditions to reduce ammonia emissions it may be worthwhile to review the modelling data and potentially to have the modelling redone.

What factors will make a difference to emission modelling?

Layout of the farm

- Our modellers have assumed that a single installation comprises a number of buildings that can be grouped together and have calculated the emission from the buildings assuming it is a point source. If the farm is on a large site or split site, such as an old airfield, it may be more appropriate to divide the buildings up into smaller groups and to model these separately rather than as a single group. Under some circumstances it may also be more appropriate to model the farm as one or more area

[1] IPPC Technical guidance note, Integrated Pollution Prevention and control (IPPC) Intensive Farming. Version 1 April 2006. http://www.environment-agency.gov.uk/business/1745440/1745496/298441/1116263/1116494/?version=1&lang=_e

[2] BREF published July 2003 by the European IPPC Bureau.

sources. (See **Table 1**). Deciding on the appropriate modelling assumptions is a complex area and expert advice should be sought.
- If the farm is in a valley, this will affect dispersion of ammonia by wind. Weather data for the local area will have been used for the model, but its appropriateness for these circumstances should be checked;
- If the farm or wildlife site is surrounded by trees, these can alter the dispersion patterns of emissions from the site. In some cases trees may act as biofilters, reducing the emissions from the farm.

Operation of the farm

- The emission factors used in modelling relate to the housing techniques and manure and slurry storage used on the farm. In some circumstances a different emission factor may be more appropriate, although justification that this is the case will need to be submitted with any modelling report. Where a novel technique not listed in the guidance 'How to Comply' is used published data or data that has been peer-reviewed will need to be supplied;
- The emission factors used in modelling are based on research undertaken in the UK by Defra or reported in the European reference document for the intensive livestock sector[3]. The emission factors are based on standard production cycles. However, where livestock are reared to lower weights than 'standard' or there is significant thinning part-way through the cycle, or the buildings are left empty for more than a week between cycles, the emission factors may need to be reconsidered. We are currently reviewing the emission factors to ensure they are as accurate as possible.
- The type of ventilation used can make a difference to the dispersion of ammonia from the installation. High velocity fans expelling air from the roof may increase the dispersion of ammonia from the farm, reducing the local impacts. Gable end fans will have a different dispersion pattern to side wall outlets, however the orientation of these fans in relation to the sensitive wildlife habitat will be a key factor.

Table 1 is designed to help you complete this evaluation.

What are the impacts on the sensitive wildlife site?

Modelling has predicted the amount of ammonia released from the farm, its dispersion, and the concentration that would be expected at the sensitive wildlife habitat. That concentration has been compared with international environmental thresholds of 1 µg/m^3 or 3 µg/m^3, depending on the type of receiving vegetation (Lower plants such as lichens and mosses are more sensitive to ammonia than higher plants such as grasses or trees.) If these thresholds are exceeded it is likely that the wildlife habitat will have been or will be damaged, and its future integrity may not be secure.

[3] Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs July 2003. European Union.

An operator may choose to set up monitoring to measure the actual concentrations of ammonia at the wildlife habitat to confirm the model predictions. Or they may choose to assess the ecological status of the site by examining the species present, to establish if there is evidence of damage from ammonia. Monitoring and ecological studies can be expensive so should only be undertaken following consultation. Ourselves and conservation agencies (Natural England and Countryside Council for Wales) can provide advice on how such investigations should be done. You should contact your relevant local office. As monitoring is likely to take some time to provide results, it should be considered alongside an emission reduction plan. If evidence of damage is found, emission reduction will be necessary. If no evidence of damage is found or monitoring shows lower concentrations than expected, then the measures required in an ammonia reduction plan may be reduced.

What happens next?

The modelling assessment completed above, gives a measure of the current emissions. The permit conditions set out the required level of reduction and/or what the acceptable concentration at the sensitive wildlife habitat is. An assessment of the techniques that can be adopted on the farm and modelling their effectiveness is needed – how much will they reduce the emissions and reduce the impact on the wildlife site. **Figure 1** sets out an overview of the process steps to take.

A number of authors have looked at ways to measure and abate emissions and the economic consequences of different ammonia abatement approaches; Phillips et al [4] ranked different techniques and concluded a combination of methods will be required; Cowell et al [5] calculated the maximum feasible reduction of around 70% of current emissions from the farm are achievable at not more than 10% of the annual value of a single animal place[6]. It is quite likely that more than one technique will be needed on the farm to achieve the required reduction in emissions at the designated site. The techniques needed will not necessarily be limited to those set out our guidance 'How to Comply', and in the Best Available Techniques Reference Document published by the European Commission. Some examples are set out in **Table 2**

The plan should include information on the cost and expected reductions which might be achieved by the techniques. Information should be provided in the plan to demonstrate that the proposed techniques will achieve the required outcome either in terms of ammonia reductions or predicted ammonia concentration over the conservation site. This may be carried out

[4] V Roger Phillips et al, An assessment of ways to abate ammonia emissions from livestock buildings and waste stores. Part 1: ranking exercise Bioresource Technology 70 (1999) 143-155
[5] David A Corwell et al, An assessment of ways to abate ammonia emissions from livestock buildings and waste stores. Part 2: Cost modelling, Bioresource Technology 70 (1999) 157-164.
[6] Annual Value = broiler or finisher value x number of cycles

either by simple calculation or rerunning dispersion models to demonstrate the effectiveness of selected techniques. In reality this stage is likely to be combined with the previous stage on the identification and evaluation of control techniques. If a particular technique seems to be effective but is novel or largely untried in the UK, then its effectiveness will need to be demonstrated either through the submission of published data or data that has at least been peer-reviewed, and the report will need to include proposals to demonstrate what emission reductions can actually be achieved.

Implementation and milestones timescale.

Once the proposed techniques have been identified, a plan should be produced to show how the measures will be implemented within the required timescale. This may need to take account of issues such as rearing cycles, existing contracts with suppliers or business continuity requirements. The plan should include milestones such as the submission of any planning application, construction start etc. so that progress toward implementation can be tracked. An example is set out in **Table 3** below.

Table 1 Evaluation of current emissions from farm

	How installation has been modelled	Example actions to take for remodelling	Likely impact on modelling
Layout of farm	Has installation been modelled as a single source, and if so, is this appropriate?	Farm is spread across old airfield and it may be more appropriate to consider it as a number of separate sources. To a first approximation if all the farm sheds and storage facilities fall within the same10^{o} arc when looking back at the farm from the wildlife site they could be considered as a single source.	It is difficult to provide advice on when more detailed modelling may be appropriate and the likely outcome as the predicted ammonia concentration from the farm will depend on the size and geometry of the buildings in relation to the prevailing wind direction and their distance to the wildlife site. However considering widely dispersed buildings as separate sources may reduce the predicted impact of the farm.
	Buildings and storage have been modelled as one or more point sources.	Although the assumption that the building can be considered as a point source for modelling purposes is robust in most cases it may be more appropriate to consider them as area sources in some circumstances, for example where the sheds are relatively long with vents dispersed along the length of the building and the wildlife site is close (within a few hundred metres) to the farm.	Ammonia released from vents down the length of a shed can effectively be considered as being partially dispersed and may result in lower predicted concentrations at a nearby wildlife site. However, the likely outcome on the predicted concentration is difficult to predict and will depend on the size and geometry of the buildings in relation to the prevailing wind direction and their distance to the wildlife site.
	Is farm in a valley? If so, is the wind rose[7] used in modelling appropriate to the orientation of the valley?	Farm is located in valley where winds generally easterly, but wind-rose used applies dominant westerly direction. Neighbouring farm has 10 years of weather data available for modelling	Dispersion to sensitive wildlife site to east will be reduced, but would be increased for wildlife site located to west.

[7] A flower-like diagram indicating the relative frequencies of different wind directions for a given station and period of time

	How installation has been modelled	Example actions to take for remodelling	Likely impact on modelling
	Is the farm or wildlife site surrounded by trees (excluding those that form part of a sensitive wildlife site)?	Farm has 50m tree-belt on boundary, between it and wildlife site.	Trees may affect dispersion and they also act as a permeable filter l absorbing some of the plume. Tree belts surrounding a wildlife site are generally more effective than trees around the farm. Smaller wildlife sites benefit more than larger sites[8,9]. Care needs to be taken to ensure that the trees themselves do not lead to adverse impacts on the wildlife site. The appropriate conservation agency should be consulted if this action is proposed.
Operation of the farm	Have the most appropriate emission factors been applied?	Broilers are grown to 35 days rather than 42.	Reduced emission release rate will result in lower emission from farm.
	Have the buildings got high dispersion fans on the roof outlets?	Roof outlets are open topped with high velocity fans.	Dispersion of air will be higher into air than from standard fans/natural ventilation and may alter the concentration of ammonia at wildlife site.
	Have the buildings got end gable fans or other additional fans?	Buildings have end gable fans possibly directing emissions away from nearby wildlife site. Some producers have fans that direct the air to the ground or the concrete floor.	Dispersion of emissions will altered by fans – more will be dispersed away from gable fan end of buildings. This will reduce the impact on wildlife site located nearer other end of buildings (non-gable end). Farm and wildlife site would need to be very close for this effect to make any appreciable difference to the predicted concentration.

[8] http://www.thepigsite.com/articles/4/waste-and-odour//1187/practices-to-reduce-ammonia

[9] Dragosits U. et al (2006). The potential for spatial planning at the landscape level to mitigate the effects of atmospheric ammonia deposition. Environmental Science and Policy 9 626-638.

Figure 1 Process steps to draw up Ammonia Emission Reduction Plan

Meeting BAT in one of the areas may be sufficient to deliver required emission reduction. If not subsequent aspects need addressing.

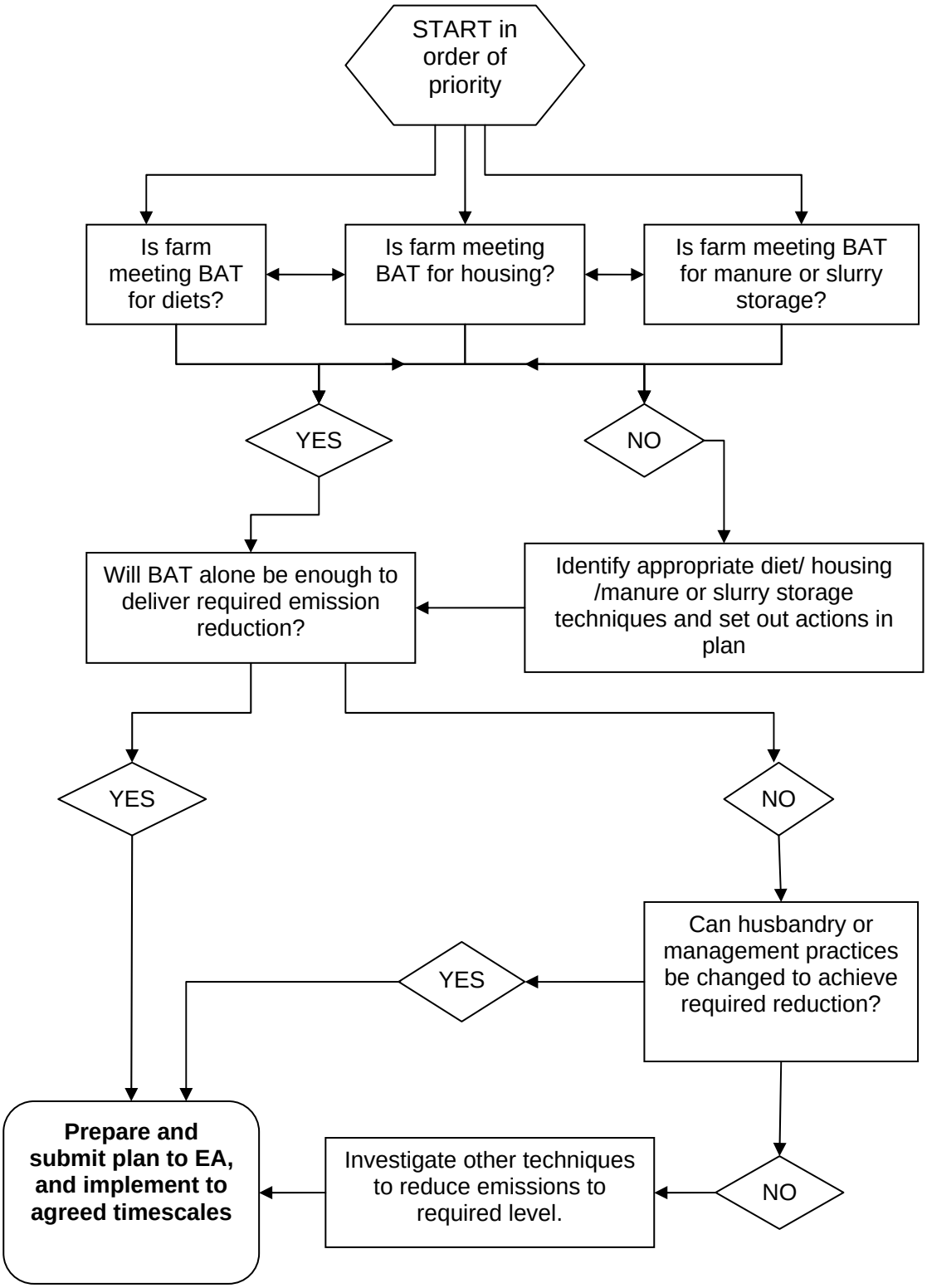

Table 2 – Some possible reduction techniques

The techniques set out in the table below are additional to those detailed in the guidance 'How to Comply' and the Best Available Techniques Reference Document. They are not the only options, but examples from recent years that are supported by published data.

	Method
2.1	In research on broilers, indicated that crops grown to produce smaller birds (for example a 35 day rather than 42 day growing cycle), would reduce total ammonia emissions Demmers et al[10] . (Likewise partial depletion before the end of the production cycle will reduce total emissions by a proportional amount.) Sites that are cleaned out quickly between cycles also produce less ammonia than others.
2.2	Change from fully-slatted floors to part-slatted with more frequent removal of slurry to a covered store or increase quantity & frequency of straw addition to absorb urine. Studies indicate that around 40% of N excreted by pigs on the straw based system and 25% on the slurry system were lost as ammonia during housing.[11]
2.3	Air exhaust treatment methods for poultry farms are being developed for houses with forced ventilation and may be considered if new houses are being built.[12] For pigs, bio filters have been developed in America to reduce emissions from deep-pit manure ventilation exhausts. Adaptation of this technology may be considered for new housing.[13]
2.4	Additives may be available which can be added to poultry litter to bind the ammonia. Covering slurry stores and employing low emission application machinery can significantly reduce emissions (by 70 -90%).[14]
2.5	There may be opportunities to reduce ammonia emissions by reducing nitrogen excretion through reducing dietary crude protein within limits.[15] We recommend that a specialist pig or poultry nationalist is consulted for further advice. The addition of fermentable carbohydrates onto grow-finishing diets can also reduce ammonia emission.
2.6	Landscaping acts as a permeable filter, slowing the emission movement and diluting the concentrations. Landscaping with both a tree line and row of shrubs at various heights with as large a surface area as possible will maximise adsorption.[16]
2.7	Reduce livestock numbers to meet the requirements
2.8	Additional modelling to demonstrate potential reduction by proposed technique/s. Mosquera et al[17] gives an overview of current methods.

[10] T G M Demmars et al, Ammonia emissions from two mechanically ventilated UK livestock buildings, Atmospheric Environment 33 (1999) 217-227
[11,14] Ammonia in the UK, DEFRA publications 2002 PB6865
[12] Lars Heyer, Big Dutchman International GmbH
[13] Thepigsite.com/articles/4/waste-and-odour/1187/practices-to-reduce-ammonia
[15] MLC. 2005a. *Finishing pigs - system research. Final report report to defra.* Report Number: Project Ls 3601..
[16] Sneath et al, Ammonia Mitigation By Enhanced Recapture (AMBER) Appendix 8, Draft Design and Management , DEFRA project code WA0719., The Poultry Site; G.t Tabler, Shelterbelts: has their time come? and Malone and Abbott-Donnelly: The benefits of planting trees around poultry farms.
[17] J Mosquera et al, Overview and assessment of techniques to measure ammonia emissions from animal houses: the case of the Netherlands, Environmental Pollution 135 (2005) 381-388

Table 3 Emission Reduction Plan – with examples in italics

	Proposed technique (See sections 5-7 in How to Comply)	Estimated reduction in emissions at site	Estimated %age reduction at habitat	Proposed timescale / milestone	Estimated cost £	Timescale agreed with Environment Agency
DIETS	*Reduce dietary protein to reduce nitrogen excretion*		*W%*	*Implement at start of next cycle*		*Completed by end 2008*
HOUSING	*Change pig housing from fully-slatted floors to part-slatted*		*X%*	*Engage building manufacturer to modify existing buildings. Construction planned for one building at a time – capacity reduced enable this to happen.*		*End 2010*
MANURE or SLURRY STORAGE	*Slurry store covered*			*Above ground tank to be purchased, planning permission sought. Sheeting a manure heap*		*End 2010* *Sept 2008*
MANAGEMENT	*Remove manure from site more frequently to temporary field heap further from the sensitive site.*			*Re-negotiate agreement with farmer who swaps straw for muck.*		*May 2008*

	Proposed technique (See sections 5-7 in How to Comply)	Estimated reduction in emissions at site	Estimated %age reduction at habitat	Proposed timescale / milestone	Estimated cost £	Timescale agreed with Environment Agency
HUSBANDARY	*Change from 42 days to 35 days broiler cycle*		*Y%*	*Negotiate new contract with supermarket in 2008 with change to new cycle by Dec 2008*		*New cycle to commence by Dec 2008*
OTHER TECHNIQUES	*Establish tree-belt along west perimeter fence. Plant required number of trees and shrubs between site and habitat along the length of the west perimeter fence*		*Z%*	*Buy additional land from neighbouring farm, obtain any planning permissions required. Plant trees/shrubs*		*2008 Establish area of trees required. 2008/09 Purchase land/permissions. 2009/10 plant trees*
	Estimated total Reduction		***W+X+Y+Z %***			