Test Protocol for Measurement of Gaseous Emissions from Land Applied Manure

Content

Foreword

To meet the environmental challenges within the livestock and agricultural production new technologies are developed within the EU member states and elsewhere. They are developed for different parts of the livestock production chain and enhance the eco-efficiency by reducing material inputs, emission of pollutants, energy consumption, recover valuable by-products and minimize waste disposal problems. These technologies are here and elsewhere referred to as environmental technologies.

However, central stakeholders, such as farmers and authorities only have limited information on their performance which hampers the diffusion of these environmental technologies in the livestock production. Therefore, the Dutch Ministry of Environment, the German Ministry of Agriculture and the Danish Ministry of Environment decided in cooperation with experts from Wageningen University & Research Centre in the Netherlands, the German Association for Technology and Structures in Agriculture (KTBL), University of Hohenheim in Germany, University of Aarhus in Denmark, the Danish Institute for Agro Technology and Food Innovation (AgroTech) and the Danish Pig Production to develop common test-protocols for test and verification of a number of these environmental technologies for livestock production. The work on the different test-protocols was initiated in October 2008 and was finalised in April 2009.

These standardized test-protocols are designed to test and verify the environmental performance and operational stability of different environmental technologies for livestock and agricultural production. Basically, the test-protocols can therefore be used to provide reliable and comparable information on the performance of new technologies to farmers, verification authorities and other stakeholder and thereby prepare the ground for that these technologies to a higher extent are used in meeting the environmental challenges of the livestock and agricultural production within the EU.

1. Introduction

The sustainability of livestock production can be improved by stimulating the use of newly developed technology and equipment designed for better ecological, i.e. eco-efficient performance. The eco-efficiency of the production is enhanced by reducing material inputs, emission of pollutants, energy consumption, recover valuable by-products and minimize waste disposal problems. These environmental technologies have been developed or are in development that can be implemented in different parts of the livestock production chain, like techniques to be applied in animal houses or techniques to storage, manure processing or application.

In order to facilitate the diffusion of environmental technologies for agricultural production it is central that these technologies' environmental performance and operational stability is thoroughly tested, making use of test protocols that incorporate the most recent knowledge on measurement methods.

Therefore, in a joint initiative of parties from Denmark, the Netherlands and Germany test protocols have been developed to test and verify different types of environmental technologies for agricultural production.

The objective of this protocol is to specify the test procedure for the eco-efficiency of technology for land application of livestock manure.

In this protocol the technology is defined as:

- System of devices that reduce the contact area between the land-applied manure and the atmospheric air.
- Treatments of manure that may affect emissions from land-applied manure.

Well known systems are trailing hoses, shallow injection, manure incorporation, the use of additives and other treatments.

The environmental pollution parameters focused on in this document are:

1) Ammonia (NH_3).
2) Odour.

Measurements of the environmental impacts of leaching of nutrients, pathogens, hormones, greenhouse gases, and heavy metals following land application of livestock manure are not included.

Likewise, this test protocol will not include test methods for measuring the spreading evenness of manure application, as test methods related to this topic already have been described by a European standard (EN 13080).

It is important that the scope and performance statements of the international verification system are defined such that its information can be optimally used by different stakeholders in the member states. This implies that the test protocol should provide a broad array of reliable information that can be analyzed and summarized during the verification in such a way that it can be directly or indirectly used by the different national users as widely as possible. However, for reasons of costs and time, test pro-

tocols have restrictions in the number of parameters to be evaluated and applied methods. The starting point in the design of the present test protocol therefore was to create an optimal balance between reliable information that meets the demands of the different users, and costs in terms of time and budgets to carry out the test procedure.

2. Scope

This protocol specifies the measuring systems required for measurement of gaseous emissions of land applied manure as basis for an environmental verification of technologies for land application of livestock manure.

The specified information includes

- a comprehensive description of the technology: working principle, system description, essential operation parameters, user manual;
- the technical performance based on data that are collected during the test period. The protocol specifies requirements for test parameters, measurement methods, sampling strategy, data collection and handling, calculation methods, reporting;
- evaluation parameters to assess the eco-efficiency of the technology;
- an evaluation of operating stability of the technology.

3. Terms and definitions

Ammonia emission
The process by which ammonia gas (NH_3) is released from a solution.

Application rate
Normally refers to the mass (tones) or volume (m^3) of manure applied per unit area of land (ha).

Broadcasting
A type of manure spreader that spreads the manure over the whole surface of an area of land.

(Deep) injection in un-cropped land
The application of liquid manure by placement or direct incorporation into the soil. This can be achieved by vertical slots, typically about 150mm deep, cut into the soil by specially designed tines.

Deep injection tines may be fitted with lateral wings to increase the lateral dispersion of slurry into the soil.

To directly incorporate the manure different kinds of tillage implements may be used. Used mainly to reduce emission of ammonia, but do also reduce emission of odour.

Greenhouse gas (GHG)
Gases that contribute to the "greenhouse effect" and global warming. Include in this context carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Shallow Injection
Shallow injection comprises a boom that supports a number of injection devices that cut slots into the soil into which livestock slurry is placed. Is mainly used to reduce ammonia emission, but may also reduce odour emission.

Land application
The distribution of manure onto land by any method

Manure
A general term to denote any organic material that supplies organic matter to soils together with plant nutrients.

Slurry
A mix of faeces and urine produced by housed livestock which is normally mixed with some bedding material and cleaning water. Livestock slurry can be pumped and normally has a dry matter content between 1 and 10 %.

Solid manure
Manure produced by housed livestock which is normally applied with a large amount of bedding material. Solid manure does not flow under gravidity and cannot be pumped. There are several different types of solid manure arising from different types of livestock housing systems.

Spreading evenness
The evenness of manure spreading. Spreading evenness has to be considered both in the transverse of the driving direction and in the longitudinal direction.

Spreading width
The widths of spread by one pass of a manure spreader.

Trailing hose applicator
A type of band spreader used for land application of livestock slurry. It may, for example, comprise a boom that supports a number of hoses that distribute livestock slurry in bands close to the ground e.g. between the rows of a growing crop on cropped land or on top of the grass in case of grassland. Mainly used to reduce ammonia emission, but may also reduce odour emission.

Trailing foot/shoe applicator
A type of band spreader used for land application of livestock slurry. It may, for example, comprise a boom that supports a number of foot- or shoe-shaped devices that distribute livestock slurry in bands on top of the soil moving away the crop or grass avoiding that way placement of manure on top of the crop or grass. Mainly used to reduce ammonia emission, but may also reduce odour emission.

4. System description

The manufacturer is responsible for providing a precise and full system description before the test starts. The system description shall include all relevant and essential information that is needed in order:

- to organize and design the test;
- to enable the farmer to operate, to maintain and to monitor the system properly;
- to on-line monitor the system including key parameters needed for the determination of the uptime/downtime of the system;
- to allow the verification authorities to check the system afterwards.

See table below.

The table has to be completed before the test is initiated.

Table 1. *Description of the environmental technology*

Manufacturer	Name of company
Model	Model name and number
Description of performance	• Reduction of ammonia • Reduction of odour • Other
Type of manure that can be handled by the technology	• Eg. solid or liquid manure • Cattle, pig, poultry, or all types of manure • Treated manure, eg. separated, digested or acidified manure types
Description of technology	• Shallow injection • Pressurized injection • Acidification • Pre-treatment of manure (describe) • Other
Size and weight of the technology	• Weight (kg) • Height (m) • Width (m) (including working width) • Length (m)
Power requirements	• kW per ton of manure handled or applied
Treatment of manure (taking place on the applicator)	• Eg. use of additives
Use of additives	• Type • Amount of additives (kg per m^3 of slurry) • Cost of the additive at the time the test is taken (Cost in local currency per volume or weight of applied manure)
Technical drawings	Should be specified on a separate page

5. Requirements

This chapter describes the requirements related to the test of gaseous emissions from land applied manure.

The requirements described include the establishment of a test organisation and a test plan as well as requirements for the test design and sampling strategy.

In addition the chapter describes the measurement parameters to be included in the test and a specification of the methods to be used.

Finally the chapter includes requirements related to the impact of the technology on occupational health and safety as well as animal welfare.

5.1 Requirements for the organisation of the test activities

The test of a new application technology involves various actors:

- The applicant which intent to have a technology tested.
- The test organization which will conduct the required tests of the technology.
- The farmer(s) which own the facilities where the tests are conducted.

Test Plan
It is required that the applicant or test organization writes, in local language, a detailed test plan based on the template in Annex A, and that all questions of the template have to be answered. To reduce the risk that the test results in the end are rejected because they have not been produced in accordance with the test protocols it is advised to confer relevant verification authorities in case of uncertainties about how to prepare the test plan.

The applicant or the test organization can decide whether the test plan shall be handled with confidence. However, in the final test report is has to be specified whether prior tests have been conducted.

Prior to start a full-scale test on application technology an evaluation of the potential risks on normal and potential unintentional use of the product shall be performed in relation to:

- Occupational health and safety.
- External environment.

Full system description of the technology tested
Prior to the test activities starts a full system description of the technology to be tested shall be available, cf. chapter 4. The description shall include detailed instructions for operation, service and maintenance and surveillance.

During the test period
During operation of the system, the applicant/manufacturer of the application technology is responsible for electronic or manual logging of a number of key parameters

to ensure the operation of the system. This logging shall include those parameters essential for the calculation of the uptime/downtime of the system, cf. chapter 4.

In the case of operational problems this should be dated and described in the test log-book by the test organization. In addition it should be dated when and how the problem is solved and signed by the farmer and the applicant/manufacturer when repairs have been finalised.

The farmer must also record the time spent on operational problems and maintenance of the application technology system.

If the applicant/manufacturer has conducted tests on earlier models of the application technology, all the test reports must be enclosed including a description of the differences between the models.

The test organisation is responsible for coordinating and implementing the test plan and for drawing up all the necessary data record tables.

In addition the test organisation must insure that the log-book is kept in the right place e.g. next to the application technology.

5.2 Requirements for the test facility and the test organization

The emissions of ammonia and odour from manure applied by an environmental manure application technology have to be related to a reference application method to allow calculation of the emission reduction efficiency of the environmental technology. The reference technology which has to be the nationwide most commonly used method for land application of the specified type of manure has to be described and specified.

The application rate has to be related to typical agricultural practice and clearly specified. During the experiments manure samples have to be taken and the manure application rate has to be measured by weighing the manure tank before and after manure application. The total ammoniacal nitrogen (TAN) applied per area shall be calculated from the weight of applied manure, the manure analysis and the surface area on which the manure was applied.

Sampling and measuring of all test parameters shall be performed by a laboratory that fulfils the general requirements of the ISO/IEC 17025. The laboratory must be accredited for testing that specific measurement unless otherwise specifically stated in the protocol.

The laboratory must be able to show that it is independent and competent.

5.3 Test design and sampling strategy

All tests of environmental technologies shall be performed according to the selected environmental parameters, ammonia and odour as described below. All tests shall be performed as case-control (reference) studies, where the case system should only deviate from the control system by the environmental technology investigated.

Table 2. *Sampling strategy for test of environmental manure application technologies*

Parameter	**Requirement**
Reference system	All tests have to be performed as case-control experiments. The control (reference system) has to be clearly defined and described.
Size of experimental plots	Circular plots having a radius of minimum 20 m in case of ammonia and more than 2,5 m^2 in case of odour
Number of experimental plots	Minimum 3 experimental plots are required for both the environmental technology and the reference technology. The test can favourably be carried out at separate times of the year, meeting that way variance in weather and field conditions.
Sampling period of year	Periods in spring to autumn (5-15˚C). Tests should not be performed if precipitation is expected within six hours after manure application
Number of sampling units	Ammonia: IHF method: 5 NH_3 traps per experimental plot Z_{inst} method: 2 NH_3 traps per experimental plot Odour: 3 sampling units per experimental plot, minimum 1 odour sampling per sampling unit
Length of sampling periods	Ammonia 6 days or more for solid manure types 4 days or more for liquid manure types Odour 20-30 minutes. The sampling has to be initiated 20 minutes after application of the manure
Composition of manure:	Solid manure: Two samples per load of applied manure per plot. Each sample has to consist of ten representatively taken subsamples. Liquid manure: Two samples per load of applied manure per plot, if the manure previously has been stirred and homogenised. Else, two samples per load of applied manure per plot, where each sample has to consist of ten representatively taken subsamples.
Definition of crop	Type and height of crop (or bare soil) in the experimental plots have to be described.
Definition of soil	The type and humidity of soil in the experimental plots have to be defined.

The data obtained by this protocol are limited to manure composed within specified limits which have to be described.

The following manure component parameters therefore have to be measured and included in the test report:

Table 3. *Measuring methods and composition of the livestock manure land-applied in the test*

Manure component	**Unit**	**Measuring methods**
Dry matter (DM)	g per kg (ww)	EØF 103˚C
Total nitrogen	g per kg (ww)	Kjeldahl/Dumas
Ammoniacal Nitrogen (TAN)	g per kg (ww)	EØF 71/393
Ash content	g per kg (dry weight)	EØF 71/250
pH	pH units	GLP, eg Metrohm, Porotrode or like
Source of manure	Cattle, pig, poultry, fur, etc.	
Type of manure	Solid, liquid, separated, acidi-fied, digested, etc.	
Application rate	Ton ha^{-1}	Weighing of the manure load before and after plot application

Homogeneous spreading of the manure is important to obtain reliable data. Therefore, the spreading evenness of the manure applied in tests has to be considered and described.

The data obtained by this protocol are highly depending on the weather and field conditions during land application and sampling. The following parameters therefore have to be measured and reported in the test report.

Table 4. *The weather and field conditions during land application and sampling. The weather conditions have to be recorded both during land application and during the period of subsequent sampling of emissions.*

Weather and field condition	**Unit**
Application time	Time of the day, day and month
Wind speed (2 m)	m s^{-1}
Wind direction	
Atmospheric humidity (2 m)	RH (%)
Radiation	W m^{-2}
Air temperature (2 m)	˚C
Soil temperature 10 cm	˚C
Soil type	Content of clay, silt, and sand
Soil moisture	g kg^{-1} soil
Precipitation	Mm

Experimental operation
The manure has to be applied on a circular plot of agricultural land with a radius varying from 20 to 24 m. The circular plot is created by applying the manure over a premarked area in parallel passes that vary in length.

The circular plot is created to achieve an equal fetch length to the centre of the plot, when wind direction changes. Manure landing outside the circular plot has to be incorporated into the soil as soon as possible to stop emission of ammonia, or the precise area of the experimental plot needs to be measured to calculate the fetch length (distance from outer boundery to central mast) with varying wind directions.

Shortly after the manure is applied to the first half of the plot – which usually is within five minutes after the start of the manure application, the central mast is placed in the centre of the experimental plot. After placement of the central mast in the centre of the plot ammonia measurements are started at both background and central masts, halfway through the manure application.

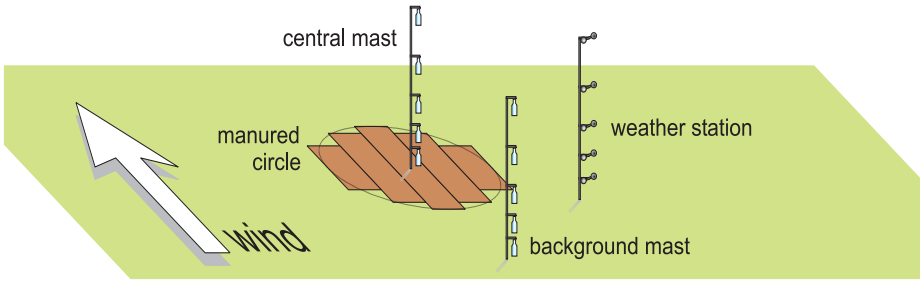

Figure 1. Layout of a circular plot for the measurement of NH_3 volatilization using the micrometeorological mass balance method, with masts supporting NH_3 traps at various heights in the centre of the plot and at the windward boundary of the plot.

5.3.1 Measurement of ammonia emission

The emission of ammonia from land applied manure shall be measured by using a test design based on the micrometeorological mass balance technique.

Micrometeorological mass balance technique
The micrometeorological mass balance technique[1] involves a measuring mast situated centrally in each experimental plot, and a background measuring mast located outside the plots for measurement of the background NH_3 levels.

Two different methods of the micrometeorological method can be used for estimation of ammonia emission from land-applied manure: The Integrated Horizontal Flux (IHF) method and the Theoretical profile shape (Z_{inst}) method[2]. The two methods have been found to produce equal results[3] and both methods can therefore be used for test of environmental land application technologies.

[1] Denmead 1983; Ryden et al., 1984; Leuning et al., 1985; Sherlock et al., 1989; Huijsmans et al., 2001
[2] Wilson et al., 1983; Thompson and Meisinger, 2004; Wilson and Shum, 1992; Klarensbeek et al., 1993
[3] Thompson and Meisinger, 2004; Klarensbeek et al., 1993; Wilson et al., 1983; Hansen, 2006

When using the IHF methods[4] the centrally located mast shall be fitted with at least five measuring units (NH_3 traps) between 0.25 and 3.30 m above the soil surface.

At the windward boundary of the plot another mast is placed with three NH_3 traps at heights between 0.40 and 3.30 m above ground level. At the boundary, fewer traps may be used because the background concentration is low and independent of height.

When using the Z_{INST} methodology[5] both the centrally located mast and the background mast have to be fitted with two measuring units mounted at a fixed distance above soil surface depending on height and roughness of crop and size of the experimental plot. Besides, the radius of the experimental plots has to be either 20 or 50m.

Ammonia sampling systems
Two systems can be used to trap NH_3: either acid bubblers or passive flux samplers.

When using acid bubblers as NH_3 traps air is drawn through an acid solution via a stainless steel inlet tube with a perforated Teflon cap. The volume of air is measured with flow meters.

The flow rate has to be 2 to 4 $dm^3\ min^{-1}$. Ion-chromatography and colorimetry are used to measure the NH_4^+ concentration in the solutions.

Passive flux samplers consists of an outer cylinder fitted with mounting pivots and fins to keep the device aligned with the wind and a detachable venturi shield which holds a thin orifice plate.

Passive flux samplers are coated before the measurements by an acid solution[6]

When passive flux samplers are used for trapping of ammonia, the determination of a wind profile is not required.

The flux of NH_3 shall be measured continuously for at least 96 hours following manure application, independent of sampling system.

In general the measurements continue for at least 96 hours (4 days) after manure application.

During the first twelve hours – when the rate of NH_3 volatilization is highest – the ammonia traps have to be replaced three to five times to avoid oversaturation of the ammonia sampling system.

Further replacement takes place every morning for the following 3 days.

The amount of NH_3 volatilized during each interval is estimated from the amount of NH_3 trapped, and from the airflow data.

[4] Wilson et al., 1992; Leuning et al., 1985, Sherlock et al., 2002; Huijsmans et al., 2001; Ryden et al., 1984
[5] Wilson *et al.*,1983; Sherlock et al., 1989; Gordon et al., 1988

[6] Leuning *et al.,* 1985

Manure samples have to be taken while the manure is being applied, often of each batch, if there is more than one.

The manure application rate is calculated from the amount applied and the area (plotsize) on which the manure is applied. The amount applied is measured by weighing the manure application device before and after manure application on each plot.

The area applied manure is measured by measuring the size of the experimental plot; this measuring is also carried out to assess the fetch to the central mast for the different wind directions.

Meteorological data
When acid bubblers are used for ammonia trapping the wind speed has to be measured with five cup anemometers placed at different heights to calculate the wind profile at the experiment location.

The meteorological mast has to be placed close to the manured plot and in the open field.

Figure 2. Meteorological mast holding cup anemometers to measure wind speed at five heights. In the background the centrally located mast holding the ammonia traps

The experimental plots of the micrometerological mass balance measuring system have to be situated at least 100 m apart, and 300 m away from ammonia emitting sources like animal houses and manure storage facilities. As a free wind-profile is required the experimental plots have to be situated as far away from wind breaks like houses and trees as possible, and no closer than 10 times the height of the wind break.

5.3.2 Measurement of odour

The effect of an environmental technology on the odour nuisance of the applied manure shall be quantified by use of a static flux chamber technique. The measuring system is described in detail by Hansen et al. (2006).

The chambers have to cover an area of manure-applied soil surface of more than 2,5 m^2 to restrict effects of inhomogeneous manure spreading. The chambers have to be equipped with oscillating internal ventilators to allow for simulation of internal wind speed and for mixing of internal air.

The external surface of the chamber has to be covered by aluminum foil to restrict unequal solar heating of the chamber during sampling. The manure-treated surface has to be covered by the static flux chamber immediately after manure application. 20 min after covering, 30 L of air is sucked from the chamber into 30-L nalophan bags by means of vacuum boxes.

The odour concentration in the nalophan bags has to be determined by dynamic dilution olfactometric analyses within 24 h (CEN, 2003). All air samples and odour analyses have to be replicated in triplicate or more.

5.4 Measurement parameters

Different sampling conditions and measuring systems have to be employed for measurement of ammonia and odour. I5.5.1. the conditions and measuring systems needed for measurements of ammonia and odour are listed.

Table 5. *Sample conditions and measuring methods for the different primary measurement parameters*

Parameter	Sample conditions	Measuring method
Ammonia	**Sampling methods:** Continuously and simultaneously measurements of ammonia flux from case and control experimental plots applied livestock manure.	The micrometeorological mass balance method. -Gas bubblers, -Passive flux samplers
Odour	**Sampling methods:** Simultaneously sampling of air above manure amended case and control experimental plots and subsequently determination of odour concentration. **Number of samplings:** Minimum 3 samples of air pre-concentrated in static flux chambers per experimental plots **Sampling equipment:** 30 l nalophan bags. **Analyses of odour samples**	Sampling methods that are in compliance with the CEN standard EN 13725/AC, 2006 Determination of odour concentration by dynamic olfactometric analyses (CEN standard EN 13725/AC, 2006)

5.5 Occupational health and safety requirements

As there is no significant manual handling involved this issue is not relevant for application technologies. The issue may be relevant for manure treatment technologies like acidification.

In general all industrial machinery and equipment – must comply with the Machinery Directive 89/392/EEC (Amended 98/37/EEC). They must be designed and con-

structed in such a way that they can be used, adjusted and maintained throughout all phases of their life without putting persons at risk.

5.6 Animal welfare

Not relevant.

6. User manual

In general, the user manual shall be written in a local language and in consideration of EN 62079:2003 (Preparation of instructions - Structuring, content and presentation) that provides general principles and detailed requirements for the design and formulation of all types of instructions.

The manual shall include the information provided with the system description according to chapter 4. In particular, it should bear instructions for:

- the operation of the system;
- the prevention of and dealing with incidents (environmental safety);
- operational health and safety measures (see chapter 5.5);
- service and maintenance;
- surveillance of the installation.

7. Test reporting and evaluation

The test report shall be written in English and, if necessary, in the local language. The report shall include chapters on the below mentioned subheadings. The following text gives a description of the contents which must be included in the chapters.

Foreword
The foreword should include a description of the three parties that have been involved in the test - the applicant, the test organisation and the farmers.

The period in which the test has been performed must also be mentioned with specific dates.

The foreword must end with the date and signatures of the person(s) who have been responsible for the test. The signature must be accompanied by the name and address of the test organisation.

Introduction
The introduction shall include a description of the manufacturer involved in the test and give a general description of their application technology system. If the applicant/ manufacturer have performed previous tests, these shall be specified, and references shall be provided.

Materials and Methods
The materials and methods section shall include a description of:

- the manure involved in the test;
- the technology including photos and any drawings;
- the measurement method.

The description of the technology shall be followed by a description of the test design, the dimensioning of the test and the measurement methods, including a specification of the measurement instruments used, the measurement points, and the measurement frequency and calibration procedures.

Furthermore the test report shall include a description of the statistical data processing method.

Results
The description of the results starts with a presentation of the application technology efficiency, which is the primary target of the test. The individual raw data shall be shown first in graphs and subsequently the processed data shall be given in tables with median, average and 95 percentile.

After the presentation of the raw data a discussion of the results shall be given.

The potential saving of artificial fertilizer shall be shown, as a value for saved nitrogen.

An evaluation of the operating stability of the system shall be given. This evaluation shall be based on observations made during the entire testing period and shall include all recorded data describing the stability of the tested technology.

Furthermore, the test report shall include an evaluation of the potential risks which may be related to the use of the system including potential impact on:

- the occupational health and safety;
- other environmental issues.

These evaluations shall include situations with normal operation of the technology system and any unforeseen use and problem.

The test report shall include advice to the verification authorities on how to inspect the system.

Finally the test report shall include an evaluation of how the results can be applied to other types of manure.

Conclusion
The conclusion describes and discusses the test results and validates the application technology in general. The conclusion chapter shall include aspect only which can be justified in the results chapter in the test report.

References
Relevant references to be specified.

Annexes
Annexes can be added if relevant.

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EN 13080 *Agricultural machinery - Manure spreaders - Environmental protection - Requirements and test methods.*

EN 13725 *Air quality – Determination of odour concentration by dynamic olfactometry.*

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Annexes

Annex A (informative) Template for a test plan

NAME OF TEST INSTITUTE

TEST PLAN FOR [name of the environmental technology]

CONTACT DATA ETC.:

Type of technology	
Name and address of manufacturer/applicant	
Facility owner (farmer):	
Address of farmer:	
Start of test of test (dd/mm/yy):	
End of test (dd/mm/yy):	
Name and address of test institute	
Responsible technician:	
Consultant(s) from the test institute:	
Contact person from the company financing the test:	
Service technician(s) from the company:	
File:	

BACKGROUND AND AIM [maximum of one page]

Include a description of the eco-efficient technology, in supplement to the description of table 1. The development of the environmental technology since previous tests shall be specified (if performed).

The section shall include a precise description of the aim of the test and a specification of the primary test parameters.

DESCRIPTION OF TEST PLAN: [In accordance with section 5. Requirements]

PROCESSING OF RESULTS

Raw data shall be presented in tables, which shall be included in appendices in the final test report. The raw data shall also be presented in graphs, which shall be included in the results section in the final test report.

The average and the standard deviation of reported emissions shall be calculated for both the reference and the environmental technology.

The measurement parameters shall be analysed in order to determine whether emissions from manure applied by environmental application technology are significantly different from the emissions from a reference application technology.

Annex B (informative) Example of a contract

CONTRACT

BETWEEN [name of the company financing the test]

AND [name of the test organisation]

AND [name of the farmer(s)]

ABOUT Test of the environmental technology called [name of product] delivered from [name of manufacturer/applicant]

****

1. AIM

1.1. The aim is to test the application technology called [name of technology] according to the test protocol called [name to be agreed on]

2. SCOPE AND TEST PROCEDURE

2.1. The enclosed test protocol states how the test shall be conducted and specifies which data recordings and analyses shall be performed.

2.2. The farmer, the company financing the test and the manufacturer/applicant shall agree that all results shall remain confidential during the test period and until the final test report is published.

2.3. Data recordings and analyses can be conducted by other institutes, provided that this is specified in the contract.

2.4. The service contracts shall be drawn up before the test starts and shall not be changed during the test period.

3. REQUIREMENTS

3.1. The results of the test shall not be manipulated to benefit the farmer or anyone else.

3.2. During the contract period, the farmer shall not conduct tests together with other parties other than the test institute.

4. VISITS / INFORMATION / ANALYSIS

4.1. The technician from the test institute collects data and provides the farmer with data recording tables. Further details of the visits are described in the enclosed test protocol.

4.2. The results of the test shall remain confidential until the results have been published.

5. TERMINATION OF THE CONTRACT

5.1. The contract runs until DD/MM/YY.

5.2. The contract is irrevocable for the farmer, the test institute and the manufacturer/applicant until DD/MM/YY.

5.3. In case of unforeseen problems the contract and test protocol can be reconsidered. If it is not possible to find a solution, the farmer, the test institute and/or the manufacturer/applicant may terminate the test with one month's notice.

6. VISITING RULES

6.1. In order to disseminate the knowledge of the new technology, the farmer shall agree to receive visits when contacted by the test institute.

7. COMPENSATION

7.1. Compensation is paid for extra work carried out during the test period. The farmer is paid DKK/Euro XXX,- per hour for extra work.

This point shall include any agreements made by the three parties regarding the amount of compensation and what the compensation covers.

8. RESPONSIBILITY

8.1.

8.2.

9. RECONSTRUCTION COSTS

9.1. Costs relating to changes or installations that can be attributed to a specific test are covered by the test institute or the manufacturer/applicant.

9.2. Equipment and material purchased by the test institute or the manufacturer/applicant belong to these parties, unless otherwise agreed.

9.3. Ownership after completion of the test shall be specified.

9.4. If the farmer terminates the present contract during the test period (see point 5.3), the test institute and manufacturer/applicant reserve the right to decide what to do with the equipment installed on the farm. The farmer can, by agreement with the test institute, acquire the entire installation at a fixed price.

9.5. If the test institute or the manufacturer/applicant terminate the present contract during the test period (see 5.3), the ownership of the installation and equipment is as specified in point 9.3. Furthermore, if the manufacturer/applicant terminates the contract during the test period, they shall pay for the measurements taken so far.

9.6. If the farmer goes bankrupt or the farm is put up for sale, the test institute is entitled to reclaim the equipment purchased by the test institute. The same applies to the manufacturer/applicant if the company goes bankrupt or closes down.

9.7. The farmer is responsible for maintaining the equipment and covering the costs of fire insurance for the equipment installed in connection with the test. The farmer is also responsible for ensuring that the equipment is in compliance with the environmental approval.

9.8 With regard to test facilities established on the farm in connection with the test, the test institute and the manufacturer/applicant are subject to the legislation of the country in which the test is performed. The test institute is therefore not liable for any operating loss and cannot be held responsible for any indirect loss arising from the test facilities.

Date and place

_____

Farmer

Date and place

_____

Applicant/Manufacturer

Date and place

_____

Test organisation