Test Protocol

for

Covers and other Mitigation Technologies for Reduction of Gaseous Emissions from Stored Manure

VERA

Version 2 / 2013-28-06

Test Protocol for Covers and other Mitigation Technologies for Reduction of Gaseous Emissions from Stored Manure

Table of contents

Foreword

To meet the environmental challenges within livestock production, new technologies are being developed within the EU member states and elsewhere. These so-called environmental technologies are designed for different stages of the livestock production chain and may potentially enhance the eco-efficiency of livestock production by reducing material inputs, emission of pollutants and energy consumption, recovering valuable by-products and minimising waste disposal problems.

However, central stakeholders, such as farmers and authorities, only have limited information about the performance of the environmental technologies, which hampers the diffusion of these technologies in the livestock production sector. The Dutch Ministry of Infrastructure and Environment, the German Federal Ministry of Food, Agriculture and Consumer Protection and the Danish Ministry of Environment, in cooperation with experts from Wageningen University & Research Centre in the Netherlands, the German Association for Technology and Structures in Agriculture (KTBL), the German Federal Research Institute for Rural Areas, Forestry and Fisheries, the German Agricultural Society DLG, the University of Hohenheim and Kiel University in Germany, the University of Aarhus in Denmark, the Danish Institute for Agro Technology and Food Innovation (AgroTech) and the Danish Pig Research Centre, have therefore decided to develop joint test protocols for testing and verification of a number of these environmental technologies for livestock production. The development of test protocols was initiated in October 2008 and the first version of this protocol was finalised in December 2009. The VERA test protocols are designed to test the environmental performance and operational stability of a range of environmental technologies for livestock production. Basically, the test protocols can be used to provide reliable and comparable information about the performance of new technologies to farmers, authorities and other stakeholders. The ground can thereby be prepared for these technologies to be used to a higher extent in meeting the environmental challenges of livestock production within the EU.

Questions and comments on the test protocols should be sent to

VERA Secretariat
Kollegievej 6
DK-2920 Charlottenlund
Denmark
info@veracert.eu

Summary

This test protocol for manure storage covers and other mitigation technologies was developed within VERA – Verification of Environmental Technologies for Agricultural Production. The protocol is a joint initiative between environmental authorities and experts from Denmark, the Netherlands and Germany with the purpose of providing a framework for independent verification of the environmental efficiency and operational stability of manure storage covers and other mitigation technologies. This test protocol is also intended to help promote an international market for environmental technologies for agricultural production.

A cover or another mitigation technology is defined in this protocol as:

- A cover system that reduces the contact area between the stored manure and the atmospheric air
- Other treatments of manure that reduce emissions from the stored manure

This protocol outlines the conditions for testing primary and conditional test parameters related to the environmental efficiency and operational stability of manure storage systems. The test focuses on verifying the efficiency of reducing ammonia, odour and greenhouse gases.

A VERA test of a storage cover or other mitigation system must be carried out by an independent test institute. This test protocol outlines detailed requirements for the actors involved: applicant/manufacturer, test institute and the farmer hosting the test facility. The test should be carried out as case-control experiments, where the case system should only deviate from the control system by the environmental technology investigated. The test should be carried out using a minimum of two case-control setups, with one sampling period in spring/autumn (5-15°C) and one sampling period in summer (15-20°C).

On completion of a VERA test, the test institute must produce a test report con¬taining a description of the technology tested, the test design and methods used. The test report must also include a presentation of the results obtained and an evaluation of the environmental efficiency and operational stability of the system.

1. Introduction

The environmental footprint of livestock production can be reduced by stimulating the use of environmental technologies designed for improving the eco-efficient performance. The eco-efficiency of livestock production is enhanced by reducing material inputs, emissions of pollutants and energy consumption, recovering valuable by-products and minimising waste disposal problems. Environmental technologies can be introduced into different stages of the livestock production chain, for example techniques for application in animal houses or techniques for reducing the emissions from manure storage, processing or land application.

In order to facilitate the diffusion of environmental technologies for agricultural production, it is crucial that the environmental performance and operational stability of the technologies are thoroughly tested. These tests should be based on test protocols comprised of descriptions of common standard methods for measuring the environmental efficiency and operational stability of an environmental technology.

In a joint initiative between Denmark, the Netherlands and Germany, protocols have therefore been developed to test and verify different types of environmental technologies for agricultural production. This initiative is organised within VERA – Verification of Environmental Technologies for Agricultural Production. VERA was established in 2009 to promote an international market for environmental technologies for agricultural production. The overall purpose of VERA is to fill the information gap for central stakeholders by offering independent verification of the environmental performance and operational stability of environmental technologies by applying specific VERA test protocols.

This document outlines the test protocol for manure storage covers and other mitigation technologies. This includes definitions, requirements and conditions for the parties involved in the test, measurement and sampling methods, processing and interpretation of measurement results, and reporting.

In general there are two types of manure storage systems:

- Slurry tanks for slurry storage
- Heaps for solid manure storage

Liquid manure is stored mainly in tanks or slurry lagoons, while solid manure is stored mainly in heaps or containers. Due to the different designs of the manure storage facilities, there are also different designs for cover systems.

Covers and other mitigation technologies are defined in this protocol as:

- Cover systems that reduce the contact area between the stored manure and the atmospheric air
- Treatments of manure that reduce emissions from the stored manure

The primary environmental pollutants focused on in this document are:

- Ammonia
- Odour
- Greenhouse gases (GHG)

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 means that the test protocol should provide a broad array of reliable information that can be analysed and summarised during the verification in such a way that it can be directly or indirectly used as widely as possibly by the different national users.

However, for reasons of costs and time, test protocols have restrictions in the number of parameters that can be evaluated and the applicable methods are limited. The starting point in the design of the present test protocol was therefore to create an optimal balance between reliable information that meets the demands of the different users, and costs in terms of time and expense in carrying out tests.

This protocol describes the requirements for testing covers and other mitigation technologies in a defined test period. The test period and the number of sampling days are determined by the requirements for a statistically adequate evaluation of the cover performance. During the test period the operational stability and any deviations from normal operational function must be observed and recorded, and reported in the test and evaluation report. However, specific test parameters for the assessment of long-term operational reliability and durability are not included in this protocol.

While it is recommended that covers and other mitigation technologies are re-evaluated 3-5 years after market introduction to assess the long-term effects and the durability of the technology, the present test protocol does not include specifications on such re-evaluation.

2. Scope

This protocol specifies the information needed for carrying out testing of covers and other mitigation technologies for reduction of gaseous emissions from stored manure.

The information specified includes:

- A comprehensive system description including user manual
- Technical performance of the manure storage covers or mitigation technology based on data collected during the test period (requirements for test parameters, measurement methods, sampling strategy, data collection and handling, calculation methods and reporting are specified in the protocol)
- Evaluation parameters to assess the environmental performance and operational stability of the technology.

After a test has been completed, verification of the environmental efficiency based on the test results can be carried out in accordance with this protocol. The test does not lead to verification of the technology itself, but only its environmental efficiency and operational performance. VERA does not endorse, certify or approve technologies.

3. Terms and definitions

Additive (directly added)

A product or substance that is manufactured or naturally occurring, which is added to manures with the purpose of modifying their biological, chemical or physical properties. Many additives are commercially available, but most have not been subjected to independent testing and their effectiveness has therefore not been assessed.

Types of additives include:

Bacterial enzyme preparations
Plant extracts
Oxidising agents
Disinfectants
Urease inhibitors
Masking agents
Acids, acidifying compounds
Adsorbents

Ammonia (NH_3)

A gas derived from urea excreted by livestock (for poultry NH_3 is excreted as uric acid) and implicated in acidification and nitrogen enrichment of sensitive ecosystems.

Ammonia emission

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

Cover technology

Cover systems for manure storage facilities can be divided into cover systems that float on the manure surface – **floating covers** – and roof systems covering the manure storage facility – **roof systems**. See below.

Downtime

The period when the system tested is not operating as a result of malfunctions.

Floating covers

Fabric membrane:

- Floats directly upon the slurry surface. Water collected on the membrane needs to be pumped away;
- Suspended from the rim of the store and floats on the slurry surface. Water collected on the membrane needs to be pumped away.

Floating layer:

- Natural crust, which may be formed by the content and residues of the slurry
- Chopped straw, which is applied upon the surface of the slurry
- Solid manure, which is applied upon the surface of the slurry
- LECA pebbles, which is applied upon the surface of the slurry
- Granules or structures made of degradable or non-degradable floating elements which are applied upon the surface of the slurry.

Greenhouse gas (GHG)

Gases that contribute to the 'greenhouse effect' and global warming. In the present context these are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

Liquid fraction

Liquid or thin fraction derived from the separation of slurry.

Manure

A general term denoting any organic material that supplies organic matter to soils together with plant nutrients, usually in lower concentrations than inorganic fertilisers.

Odour

Pleasant or unpleasant smell caused by different odorants with very different chemical, physical and biological properties. The odour concentration is given in European Odour Units per cubic metre of air (OUE/m^3) and the concentration is measured by olfactometric analyses in accordance with European CEN standard EN 13725.

Roof systems (cover technology)

Tent roof:

Tent roofs have a central supporting pole with spokes radiating from the top. A fabric membrane is spread over the spokes and is tied to a rim-bracing. Tent roofs need to have ventilation openings to avoid the risk of methane accumulation.

Rigid covers:

A rigid cover can be a flat deck or a conical roof. It is usually designed at the outset and is erected at the same time as the store. A flat deck is usually made of concrete, while a conical roof can be made of fibreglass. A flat deck usually has to be supported by joists.

Slurry

Faeces and urine produced by housed livestock, usually mixed with bedding material and water during management. The dry matter content of slurry is usually in the range 1-10%. Slurry is a mixture

of liquid and solid materials, where the majority of the solid material is typically undissolved in the liquid phase and therefore precipitates from the liquid during longer periods of storage.

Solid manure

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

Uptime of the system

The period of time when the system tested is functioning.

4. System description

The manufacturer/applicant is responsible for providing a precise and full system description of the technology before initiation of a VERA test. This information should be provided as essential data for the test institute, users of the system, verification authorities, etc. and to some extent also forms part of the final test report. The system description must include all relevant and essential information that is needed to:

- Organise and design the test
- Enable the farmer to operate, maintain and monitor the system properly
- Monitor the system on-line, including the key parameters needed for the determination of uptime/downtime of the system (only where relevant)
- Allow the verification authorities to check the system after a test has been carried out
- Provide insights into the working mechanisms of the system.

Different descriptions are required for cover systems and manure treatment system (see Tables 1 and 2 below). These tables have to be completed before the test is initiated.

Table 1. System description of cover technology

Manufacturer	Name of company
Model	Model name and number
Description of performance	• Reduction of ammonia • Reduction of odour • Reduction of GHG • Other
Type of manure that can be covered by the technology	• Solid or liquid manure • Cattle, pig, poultry, or all types of manure • Treated manure, e.g. separated, digested or acidified manure types
Description of technology (includes a short description of material and performance)	• Floating layer (describe material) • Tent (describe material) • Rigid cover (describe material)
Size and weight of the technology	• Weight (kg per area) • Thickness of material (mm) • Min/max area (m^2)
Openings (only airtight materials)	• Area (m^2) • Relative to total cover area, %
Agitation (needed for stirring of the manure) **and treatment of manure** (taking place in the store)	• Mechanical • Use of additives • Other
Technical drawings	Should be specified on a separate page

Table 2. System description of manure treatment systems

Manufacturer	Name of company
Model	Model name and number
Description of performance	• Reduction of ammonia • Reduction of odour • Reduction of GHG • Other
Type of manure that can be handled by the technology	• Solid or liquid manure • Cattle, pig, poultry, or all types of manure • Treated manure, e.g. separated, digested or acidified manure types
Description of technology (include a short description of technology and performance)	• Ozonation • Acidification • Other additives (describe) • Other (describe)
Use of additives	• Type of additive • Amount of additive (kg/ton or m^3 of manure • Cost of additive at the time of the test (cost per volume or weight)
Energy requirement	KWh per storage period and/or mass of manure
Technical drawings	Should be specified on a separate page

In addition, the description must include detailed instructions on operation, maintenance and monitoring.

The manufacturer/applicant must provide general information about:

- Environmental and occupational safety of the technology applied
- Essential parameters for the calculation of the uptime/downtime of the system (although the test institute is responsible for a professional evaluation of whether this information is reliable and sufficient)
- Predicted durability of the system and its components
- Warranty provisions.

User manual

The user manual for the technology must be available in the local language. It must be written in consideration of EN 62079:2003 *Preparation of instructions – Structuring*, content and presentation, which provides general principles and detailed requirements for the design and formulation of all types of instructions, and Machinery Directive 2006/42/EC, which provides the regulatory basis for the harmonisation of essential health and safety requirements for machinery.

The user manual must include the information provided with the system description according to the descriptions above in this chapter and should in particular include instructions for:

- The operation of the system and technical installations
- The prevention and handling of incidents (environmental safety)
- Operational health and safety measures
- Service and maintenance
- Monitoring of the installations.

5. Requirements

This chapter describes the requirements related to the testing of covers and other mitigation technologies for gaseous emissions from stored manure. The requirements described apply to the planning of test activities, test facilities and the test institute, as well as requirements for the framework and contents of the test plan.

In addition the chapter describes the measurement parameters to be included in the test and a specification of the methods to be used and of the persons/organisations responsible for providing the specified information. Finally, the chapter describes the requirements relating to the impact of the system on occupational health and safety and animal welfare.

5.1 Pre-testing or full testing of a technology

The test protocol can be used during the phases of developing a new technology (pre-testing), as well as for testing a final technology (ready for commercial launch) with the aim of VERA verification.

It is strongly recommended that pre-testing of a new technology be carried out before a full VERA test is initiated. It is also recommended that a full test only be initiated when the system/technology has been proven to be stable and functional.

During pre-testing of a technology, parts of the test protocol can be used in order to clarify and optimise the performance and stability of a new technology. The manufacturer may visit the test facility at any time during pre-testing.

However, during a full test of a technology with the aim of VERA verification, all the requirements mentioned in the following sections have to be fulfilled.

This means that the results from pre-testing can only be used as part of the results from a full test if all the specific requirements listed below (5.2-5.6) are fulfilled, which includes requirements on quality-related issues and restrictions on farm visits and modifications of the technology.

5.2 Requirements on organisation of the test activities

The test for a new cover or treatment technology involves various actors:

1. The applicant/manufacturer wishing to have a technology tested.
2. The test institute that carries out the required test.
3. The farmer(s) who own the facilities where the tests are carried out.

Certain requirements are related to each of these three categories of actors as described in the following sub-sections.

Test plan

It is recommended that the applicant or test institute writes (in the local language) the test plan based on the template in Annex A, and that all questions included in the template are answered. To reduce the risk of test results being rejected by the verification authority due to inconsistencies between the test results and protocol requirements, it is advisable to consult the relevant verification authorities in the event of uncertainties about preparations of the test plan.

The applicant or the test institute can decide whether the test plan should be treated as confidential.

Full system description of the technology tested

The applicant/manufacturer is responsible for providing a full description of the system of the technology to be tested prior to the start of a full VERA test, cf. chapter 4. The description must include detailed instructions for operation, service, maintenance and monitoring.

Requirements and restrictions during the test period

During operation of the system, the applicant/manufacturer is responsible for electronic or manual logging of a number of key parameters to check the operation of the system. This logging must include those parameters essential for the calculation of the uptime/downtime of the system, cf. chapter 4.

The applicant/manufacturer of the technology is not allowed to visit the farm during the test period unless contacted by the farm owner concerning operational problems. In such cases, the operational problems must be dated and described in the test logbook by the farmer or the test institute. In addition, a dated record must be made of when and how the problem was solved, to be signed by the farmer and the applicant/manufacturer when repairs have been completed.

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

The test institute is responsible for co-ordinating and implementing the test plan and for drawing up all the necessary data record tables. Furthermore, the test institute is responsible for calculation of the uptime/downtime of the system tested.

The logbook must be made available to the farmer and the test institute at any time during the test period.

The farmer is responsible for recording the production conditions in accordance with the test plan. The farmer must also record the time spent on operational problems and maintenance of the cover technology system.

5.3 Requirements on the test facility

The storage cover technology must be tested under farm conditions that are representative of standard practices for which the technology is intended for use. If the technology is tested in small-scale designs (min. 4 m^3 slurry containers), the test should be designed to allow complete comparability between small-scale and farm-scale storage facilities. This means that requirements need to be defined to ensure that both the design of the test facility and the management conditions during the test period are representative of the farm characteristics concerned. The emissions of ammonia, odour and GHGs from stored manure after applying a cover or other mitigation technology must be compared with the ammonia, odour and GHG emissions from a reference storage method (case control test design, for example no cover), in order to allow calculation of the emissions reduction efficiency of the environmental technology. The reference technology (which has to be the most commonly used method nationwide) has to be described and specified.

5.4 Requirements on the test institute

General requirements on the test institute to ensure adequate quality of all activities related to the test measurements and reporting are specified in this section.

The test institute and laboratories involved must fulfil the following requirements:

1. Sampling and measuring of all test parameters listed in Table 3 must be carried out by laboratories accredited according to ISO/IEC 17025 *General requirements for the competence of testing and calibration laboratories*. In addition, it is recommended that the test institute fulfil the general requirements of ISO 9001 Quality management.

2. For specific measurement parameters, as defined in section 5.6, laboratories must fulfil the specific requirements of the quality standard indicated.

3. The test institute and laboratories involved must demonstrate relevant experience and expertise to the International Verification Committee (IVC). Relevant experience should include measurement experience in livestock production in general. The technicians and researchers involved should have a thorough understanding of livestock production systems and their management. The test institute must demonstrate its ability to combine measurement experience and livestock production expertise into data collection, handling, analysis, interpretation and reporting to meet the standards of sound research.

4. The test institute must demonstrate its independence from the other actors involved.

5.5 Test design and sampling strategy

Tests on both liquid manure (slurry) and solid manure systems must be carried out according to the selected environmental parameters, ammonia, odour and GHG as described below. All tests should be carried out as case-control studies, where the case system should only deviate from the control system by the environmental technology investigated.

Table 3. Sampling strategy during test of covers or other mitigation technologies

Parameter	Requirement
Number of storage units for sampling (replicates)	Minimum 2 case-control experiments
Minimum size of storage units	4 m^3 of manure
Sampling period of year	One in the period of spring/autumn (5-15˚C) One in the period of summer (15-20˚C)
Length of sampling period	**Ammonia** 60 days or more for solid manure 30 days or more for liquid manure
	Odour: Between 20 and 60 minutes
	GHG: 90 days or more for solid manure 30 days or more for liquid manure types
Composition of manure:	**Solid manure:** Two samples per storage unit, where each sample has to consist of 10 representatively collected subsamples.
	Liquid manure: Two samples per storage unit if the manure has been previously stirred and homogenised. Otherwise, two samples per storage unit, where each sample has to consist of 10 representatively collected subsamples.

Emissions of polluting gases from manure storage facilities must be measured in a closed dynamic chamber system, which partly or fully encloses the storage facility during sampling.

Restrictions on use

The closed dynamic chamber system is well suited for measurements of emissions of polluting gases from stored manure. However, the closed dynamic chamber system is not suited for the purpose of measuring emissions from manure storage facilities covered with tent roof systems, or covered with airtight fabric membranes. For these systems, no agreed test methods are yet available.

The closed dynamic chamber system can be used for measurement of different polluting gases. However, the sampling strategy is dependent on type of manure and type of polluting gas.

Description of the closed dynamic chamber system

The closed dynamic chamber system consists of a stationary or mobile chamber covering the manure storage system during sampling (Amon et al., 2001; Chadwick, 2005). Each chamber has to be mechanically ventilated to allow fresh air to enter the chamber via an inlet. In the chamber, the fresh air accumulates the emissions from the stored manure before it is pumped out of the chamber. Concentrations of gases have to be measured in both the incoming and outgoing air.

The differences in concentrations of specific gases between the incoming and outgoing air represent the emissions from the substrate inside the chamber. The air flow entering and leaving the chamber has to be recorded continuously by flow meters. The gas flux is calculated by multiplying the average air flow by the net gas concentration in air entering and leaving the chamber. The net emissions then have to be divided by the surface area or volume of the stored manure. As emission rates are influenced by the concentration of gases in the chamber, the dilution rate of chamber air needs to be recorded and specified.

Composition of the manure used

The data obtained by this protocol are limited to manure with a composition within specified limits that have to be described. The following manure component parameters therefore have to be measured and included in the test report

Table 4. Composition of the livestock manure used in the test

Manure component	Unit	Measuring method
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)	71/393/EØF
Ash content	g per kg (dry weight)	EØF 71/250
pH	pH units	GLP, e.g. Metrohm, Porotrode or similar
Source of manure	Cattle, pig, poultry, fur animals, etc.	
Type of manure	Solid, liquid, separated, acidified, digested, etc.	
Age of manure	Days of storage prior to measurement	

Weather parameters

The data obtained by applying this protocol are highly dependent on the weather and environmental conditions during storage and sampling. The following parameters must therefore be measured and reported in the test report.

Table 5. Environmental and weather conditions during sampling

Climatic condition	Unit
Time of year	Calendar month
Wind (2 m)	m s^{-1}
Atmospheric humidity	RH
Air temperature (2 m)	˚C
Manure temperature	˚C

5.6 Measurement parameters

Different sampling conditions and measuring systems have to be employed for measurement of the different types of polluting gases. A list of conditions and measuring systems needed for measurement of ammonia, odour and GHG is presented in Table 6.

Table 6. Sample conditions and measuring methods for the different primary measurement parameters

Parameter	Sampling conditions	Measuring method
Ammonia	**Sampling period:** Sampling must be performed in spring/autumn and summer periods **Sampling methods:** Continuous and simultaneous measurements of ammonia concentrations from inlet and outlet air **Length of sampling period:** Solid manure, minimum 60 days Liquid manure, minimum 30 days	Closed dynamic chamber system Gas bubblers, Photo-acoustic monitors, FTIR spectrometer
Odour	**Sampling period:** Sampling in spring/autumn and summer periods **Sampling methods:** Simultaneous sampling of outlet air for determination of odour concentrations **Length of sampling period:** Two sampling days per test **Number of samplings:** Three samples of outlet air per treatment and sampling day **Sampling time:** Between 20 and 60 minutes **Sampling equipment:** 30-L nalophan bags.	Closed dynamic chamber system Sampling methods that are in compliance with CEN standard EN 13725/AC: 2006 – Determination of odour concentration by dynamic olfactometric analyses
GHG	**Sampling periods:** Samplings in spring/autumn and summer periods **Sampling methods:** Either continuous on-line measurements in inlet and outlet air by photo-acoustic monitoring measuring systems or manual samplings of inlet and outlet air for GC analyses. If manual GC sampling is used, sampling must be performed three times per week in periods when emission rates are expected to be high and twice per week in periods when emission rates are expected to be low. **Length of sampling period:** Solid manure, 90 days Liquid manure, 30 days **Sampling equipment (GC analyses)** 5-mL glass bottles fitted with butyl rubber septa pre-flushed with at least 35 mL of sampling air.	Closed dynamic chamber system Photo-acoustic monitors, GC-FID (CO_2, CH_4,), GC-ECD (N_2O)

5.7 Occupational health and safety requirements

As there is no significant manual handling involved, this issue is not relevant for cover technologies.

The issue may be relevant for manure treatment technologies such as acidification.

In general, all industrial machinery and equipment must comply with the Machinery Directive 89/392/EEC (Amended 98/37/EEC). It must be designed and constructed in such a way that it can be used, adjusted and maintained throughout all phases of its life without putting persons at risk.

5.8 Animal welfare

The operations will not have any influence on animal welfare.

6. Test report and evaluation

This chapter describes the requirements on the test report, including formalities for system and test description, data handling, statistical analysis, etc.

The test report must be written in English and, if necessary, in the local language. The report must include chapters with the subheadings listed below. The following text gives a description of the contents that must be included in the chapters and the contents of the individual sections.

Foreword

The foreword should include:

- A description of the three parties involved in the test – the applicant, the test institute and the farmer(s) – and their respective roles during the test period
- Specification of the test period, including dates
- Date and signatures of the person(s) responsible for the test
- Name and address of the test institute.

Introduction

The introduction must include a description of the background regarding the environmental need for implementation of the technology in question, a description of the manufacturer involved in the test, and a general description of the manure storage cover to be tested. The introduction should include an explanatory description of how the system/technology tested can meet these environmental challenges by decreasing emissions of environmental pollutants and thereby reducing the overall environmental effect of the agricultural production system in question.

In addition, the introduction must include a description of the applicant/manufacturer involved in the test and give a general description of the cover/mitigation technology. If the applicant/manufacturer has carried out previous tests, these must be described and references provided.

Materials and Methods

The materials and methods section must include a description of:

- The manure involved in the test
- The technology, including photos and any drawings
- The measurement method applied and its measuring uncertainty. If the method applied deviates from those described in this protocol, the method should be thoroughly described.
- Sampling procedure 'where, when and how'
- Description of calculation and statistical methods used.

The test design must be described, including dimensioning of the test and measurement methods, with a specification of the measuring instrument used, the measurement points, the measurement frequency and calibration procedures.

Furthermore the test report must include a description of the statistical data processing method used, including models and the statistical software package.

Results

The description of the results must start with a presentation of the efficiency of the cover technology in terms of reduction of emissions of ammonia, odour and greenhouse gases, which is the primary target of the test. The individual raw data must be shown in graphs and subsequently the processed data must be presented in tables with median, average and 95 percentile.

After the presentation of the raw data, a discussion of the results must be presented.

A mass balance for nitrogen must be presented.

The average and standard deviation of the supplementary measurement parameters must be presented in tables and commented on in the text.

An evaluation of the operating stability of the system must be given. This evaluation should be based on observations made during the entire test period and must include all recorded data describing the operational stability of the technology.

The uptime of the technology during the test period must be calculated, as well as the efficiency of the technology corrected by the uptime factor. [1]

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

- Occupational health and safety
- Other environmental issues

These evaluations must cover situations with normal operation of the technology system and any unforeseen use and problems. Furthermore, the test report must include an evaluation of how the results can be applied to other types of manure.

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

In cases where the verification body deems it necessary, the raw data should be made available by the applicant or the test institute for interpretation of the results and conclusions presented.

Discussion and Conclusions

The results must be discussed in relation to aspects of the working principle of the system, the plausibility of the results and findings in related research reports.

[1] If, for example, the cleaning efficiency of a technology is 90% and the uptime is 80% the corrected efficiency of the technology is 72%.

The conclusions section must sum up the major results and validate the cover/mitigation technology in general. The conclusions section should only include aspects that have been verified in the results section in the test report.

References

Relevant references to be specified.

Annexes

Annexes can be added if relevant.

Bibliography

Amon B., Amon T., Boxberger J., and Alt C. 2001. *Emissions of NH_3, N_2O and CH_4 from dairy cows housed in a farmyard manure tying stall (housing, manure storage, manure spreading).* Nutrient Cycling in Agroecosystems. 60:(1–3) 103–113.

Beauchamp, E.G.; Kidd, G.E.; Thurtell G.W. 1978. *Ammonia volatilization from sewage sludge applied in the field.* Journal of Environmental Quality, 7: 141-146.

Chadwick D.R. 2005. *Emissions of ammonia, nitrous oxide and methane from cattle manure heaps: effect of compaction and covering.* Atmospheric Environment 39: 787–799.

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

EN 62079:2003 *Preparation of instructions – Structuring, content and presentation.*

ISO 12100-2:2003 *Safety of machinery – Basic concepts, general principles for design* – Part 2: *Technical principles.*

ISO/IEC 17025 *General requirements for the competence of testing and calibration laboratories.*

Annexes

Annex A (informative) Template for a test plan

Name of test organisation

Test plan for [name of cover or treatment technology]

Contact data etc.:

Type of technology	
Name and address of manufacturer/ applicant	
Facility owner:	
Address of owner:	
Visiting rules:	
Start of test of test (dd/mm/yy):	
End of test (dd/mm/yy):	
Name and address of test institute:	
Responsible technician:	
Technician(s):	
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]

A short description of the system and a reference to where details can be found should be included. The development process of the system and any previous tests must be specified (all references must be included in the reference list at the end of the test plan).

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

Test procedure

In accordance with section 5, Requirements.

Data recording

The tables provided for recording data must be presented.

Allocation of responsibility

The allocation of responsibility must cover all working processes in the system/technology, so that the technician can use the list when instructing stockmen.

A list must be drawn up for each section and system/technology.

What needs to be done	When	By whom

Processing of results

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

The average and the standard deviation of reported emissions must be calculated for both the reference and the cover/mitigation technology.

The measurement parameters must be analysed in order to determine whether the emissions from the storage facility with an environmental technology are statistically different from the emissions from the reference storage facility.

Annex B (informative) Example of a contract

CONTRACT

Between [name of the company financing the test]

And [name of the test institute]

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 must be carried out and specifies which data recordings and analyses must be performed.

2.2. The farmer, the company financing the test and the manufacturer/applicant should agree that all results must 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 must be drawn up before the test starts and must not be changed during the test period.

3. Requirements

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

3.2. During the contract period, the farmer must not conduct tests together with any 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 must 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 the 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 to what the compensation refers.

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 must 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 institute

VERA

VERA Secretariat
Kollegievej 6
2920 Charlottenlund
Denmark
Phone: (+45) 39 96 61 30
E-mail: info@veracert.eu
Web: www.veracert.eu