



Overview of the DLG Testing Framework 'exhaust air cleaning in animal production' (status: June 2022)

The new version of the German Technical Instructions on Air Quality Control (TA Luft) means that the testing and certification of exhaust air cleaning systems are becoming highly important, as only quality-assured procedures should be used in systems that are subject to mandatory approval. In this context, the DLG Testing Framework is often mentioned as an orientation aid for performing and evaluating the test. The key points of the DLG procedure are summed up in the following.

(DLG). The DLG (German Agricultural Society e. V.) Test Center Technology and Farm Inputs tests the utility value, i.e. the fundamental suitability, of exhaust air cleaning systems under practical conditions when they are used to reduce emissions in pig sties, cow sheds or poultry houses. The DLG test therefore extends far beyond a pure emission measurement. This offers the advantage that all of the parties concerned – approval authorities, manufacturers and farmers – can rely on the functional capability of certified systems when these are operated properly.

The prerequisites for testing an exhaust air cleaning system is the acceptance of system construction in accordance with building law approval, adherence to the requirements of the German Animal Protection and Keeping of Production Animals Ordinance and the species-specific husbandry regulations as well as the functional capability of the system. Any necessary biology adaptation periods or corresponding running-in times must also be taken into consideration for this. The manufacturer is additionally obliged to submit the complete documentation of its system for the test.

Prerequisites for applying for a DLG test by the manufacturer

A complete description of the system with the following information content must be available:

- a) Meaningful operating instructions with a detailed functional description of the exhaust air cleaning system incl. exact dimensioning (floor plan, technical drawing with dimensions, etc.)
- b) A comprehensive dimensioning plan (filter area load, filter volume load, irrigation density, desludging, technical nominal values such as pH value, pressure loss, conductivity, etc.)
- c) A precise description of the production system to be examined, with a description of the animal species, the production method, feeding, the ventilation system, substance storage, etc.
- d) An overview of the consumption data to be anticipated in practice
- e) Verification of the checking of proper operation by means of a user manual, an electronic (EOL) and, if necessary, a manual operating log (MOL). The EOL must at least contain the parameters listed in TA Luft (Chapter 5.4.7.1 Measurement and monitoring)
- f) Revision and maintenance plan, system cleaning information
- g) Performance and dimensioning data for significant parts of the system (packing material, pumps, nozzles, measuring devices, etc.)

A) Prerequisites for conducting the test

- a) Accreditation of all involved test and measurement laboratories in accordance with ISO 17025. The corresponding parameters (ammonia, dust, odour, possibly bio-aerosols) must be accredited individually. In addition, the consumption data and the volumetric flows must be

reliably recorded and continuously stored by the measurement institute. The measurement institute must be able to reliably determine a volumetric flow characteristic curve at the location to be tested (e.g. SF₆ tracer gas, network measurement, etc.).

- b) Accompaniment of the procedure by an independent test commission that tests the exhaust air cleaning system to be measured prior to the start of the measurements, releases the measurement plans to be produced and reviews the test body's measurement reports to determine whether the requirements in accordance with the agreed procedure and the required cleaning performances are reliably complied with.
- c) A reference system must be available to enable testing of the animal species favoured by the applicant using the corresponding husbandry form. The statutory requirements (German Animal Protection and Keeping of Production Animals Ordinance (TierSchNutztV), DIN 18910, German Ordinance on Facilities for Handling Substances Hazardous to Water (AwSV), etc.) must be complied with at the location, as recognition is otherwise not possible. Meeting these requirements is checked by DLG.

B) Definition of the measurement programme

The measurement programme is defined in coordination with the DLG Test Commission and the commissioned measurement laboratory during an inspection of the system to be tested.

In the case of continuous production methods (e.g. laying hens, fattening pigs, breeding sows), the measurement period encompasses an eight-week measurement phase in the summer and an eight-week measurement phase in the winter. Maximum operating conditions should be tested in the summer (high outdoor temperatures, high stocking density) and minimum operating conditions in the winter (low outdoor temperatures, low stocking density).

In the case of cyclical production methods (e.g. fattening poultry, < 3 months per throughput), the measurement period encompasses four complete throughputs, two each in the summer and winter. Maximum and minimum operating conditions should be achieved in this process, and should be achieved repeatedly over several days if possible.

Only complete and interconnected throughputs can ever be evaluated. An air rate with at least 80% of the design air rate per animal on several days can be used as a guideline value for the summer measurement, and air rate with a maximum of 30% of the design air rate per animal on several days can be used for the winter measurement.

The system should be in regular operation for at least four weeks prior to the start of the actual measurements. This serves to ensure stable operating conditions and should also be verified by means of the electronic operating log (EOL).

The following are usually measured or recorded **each week**:

- a) Odour
- b) Total dust (PM fractions, see below)
- c) Number and weight of the animals
- d) Temperature in the sty/shed/house, in the untreated gas and in the clean gas
- e) Relative humidity in the sty/shed/house, in the untreated gas and in the clean gas
- f) Air volumetric flow (control)
- g) Exhaust air cleaning system pressure loss
- h) Temperature, pH value and conductivity value in the washing water
- i) Substance consumptions or meter readings (fresh water, waste water, consumption of energy, acids, lyes, approved nitrification inhibitors and other substances, insofar as these are used)

The dust fractions PM₁₀ and PM_{2.5} (PM_{2.5} for information purposes only) are measured at least twice in the winter and twice in the summer.

In addition, the release of aerosols is determined at least twice under summer conditions and is also evaluated in terms of the related N discharge.

Insofar as the system is also to be accredited for the separation of bio-aerosols, at least two measurements are conducted under winter conditions and two measurements under summer conditions. Besides the live cell count (bacteria), mesophilic fungi (25°C) and, if necessary, key animal species-specific microorganisms are also recorded in this process.

Recording additional or other parameters may prove necessary in individual cases (e.g. on use of

oxidising agents). Some of the above specified parameters may have to be measured more frequently if necessary.

The following are measured **continuously**:

- a) Volumetric flow [m³/h]
- b) Ammonia in untreated and clean gas (throughout the entire measurement period) and one measurement point in the sty/shed/house at the animals' head height (compliance with the German Animal Protection and Keeping of Production Animals Ordinance)
- c) NO, NO₂ and N₂O in untreated and clean gas during the balancing periods
- d) Relevant pressure losses, e.g. filters, filter walls
- e) Relevant water volumes, e.g. circulation volume, pilot spraying, desludging, fresh water consumption
- f) Exhaust air cleaning system energy consumption

In the case of fattening poultry systems, the influence of manure removal is also recorded subsequent to the tested fattening throughput by continuously determining ammonia separation with the system running. This enables verification of whether the separation efficiency is guaranteed even with increased ammonia loads.

N balancing is carried out at least once in the winter and once in the summer over a period of at least two weeks in each case. The highest-emission period should be recorded in the summer. N balancing serves multiple purposes:

- Verification of the whereabouts of the nitrogen
- The avoidance of secondary emissions (ammonium/water droplets, secondary trace gases)
- Checking the plausibility of the overall procedure (e.g. detection of possible losses due to leaks in the sump of scrubbers)

C) Verification of proper operation

Exhaust air cleaning systems must have an electronic operating log (EOL) in which operation-relevant data are stored in the form of half-hour values over the past five years. The relevant parameters are selected according to the procedure to be tested.

The following must generally be registered and recorded:

- i) Energy consumption of the exhaust air cleaning system, cumulative (EACS) [kWh]
- ii) EACS substance consumption if applicable/necessary (fresh water, acid*, lye*, other additives*, etc.), cumulative [kg] or [l]
- iii) Desludging (scrubber), cumulative [m³]
- iv) Volumetric flow [m³/h]**
- v) Untreated air temperature [°C]
- vi) Clean air temperature [°C]
- vii) Differential pressure of the EACS [Pa] or [mbar]
- viii) pH and conductivity in the case of exhaust air scrubbers or multi-stage systems [- ; mS/cm]
- ix) Conductivity in the biological stage water [mS/cm]***
- x) Washing water circulation volume [m³/h]
- xi) Nitrification inhibitor consumption, cumulative [kg]

*The consumption of these substances can also be recorded in a different form (purchasing invoices, manual or electronic operating log). Nitrification inhibitor consumption must be recorded in the EOL

**Recording using calibrated measuring fans or registration of the characteristic curve field based on the percentage air output with 5 support points (20/40/60/80/100% of the air output)

***Required as soon as the water from the biological stage is to be transferred to the chemical stage in a controlled manner

The calibration times of the pH value sensors, maintenance and repair periods as well as the spray pattern check must additionally be registered. This can be done both electronically and manually.

If the EACS is used on a poultry fattening house, the operating time of the emergency ventilation must additionally be registered electronically.

D) Minimum requirements for cleaning performance and other requirements

The minimum requirements (Tab. 1) are to be understood such that all calculated efficiencies must comply with or exceed the minimum requirements. The system should therefore guarantee the minimum degree of separation at all points in time. When measuring ammonia, the efficiencies are only determined and taken into consideration for untreated gas values of > 3.3 ppm due to measurement technology reasons for FTIR analysers.

Failure to meet the minimum requirements can also be accepted in justified exceptional cases insofar as this is attributable to disturbances or malfunctions and is not based on proper operation. However, this must be clearly documented.

All requirements must be met *without taking measurement uncertainties into consideration*.

Table 1: Minimum requirements for the cleaning performance of exhaust air cleaning systems

Parameter	Minimum separation/minimum requirement	Remarks
Ammonia	70%	All HHMV _{s1}) > 70%
N removal₂	70%	In the winter and the summer
Total dust	70%	Each measured value over 70%
PM₁₀	70%	Each measured value over 70%
Odour	Max. 300 OU/m ³ in the clean gas ₃)	Applies to each value
	NUP ₄)	Applies to each value
Bio-aerosols (optional₅)		
Live cell count, bacteria, 25°C	70%	Applies to each value
Mesophilic fungi, 25°C	70%	Applies to each value
Key microorganism (variable)	70%	Applies to each value

1) HHMV: half-hour mean value

2) N removal is understood to mean that at least 70% of the nitrogen introduced with the untreated gas during the balance period are removed from the system in manageable form (e.g. in the form of desludging water). Both balances must result in N removal of at least 70%.

3) Applies to pig production only. The limit value does not include any measurement uncertainty. The following applies to fattening poultry production: technical efficiency of > 50% for each measured value, omission of the NUP criterion.

4) NUP: no untreated gas odour perceptible in the clean gas.

5) Measurement and representation in the DLG test report can be freely selected by the manufacturer. The minimum requirements must be met in the event of publication.

Besides cleaning performances, procedure-relevant process data must also be documented properly in the electronic operating log. The data must be clearly defined, correct and complete. It must be possible to read the EOL data and graphically represent them in tabular form using commercially available software.

The test cannot be completed successfully without a complete and properly usable EOL. The plausibility of the EOL is checked four weeks prior to the test and during the measurement phase.

The substance consumptions determined in the context of the test (energy, fresh water, etc.) and the residual substances incurred (washing water, filter materials) are specified in absolute and cumulative form. Specific key data are additionally specified with reference to the animal space and an operating time of 365 days per year.

Technical defects, expenses for repair and maintenance as well as further information about

anomalies (deposits, corrosion, etc.) during the course of the test must be indicated.

N balancing (the recovery rate of the separated nitrogen) must be less than 80% or higher than 120% during the balancing period.

E) Check of system safety with respect to personal protection (occupational safety)

The exhaust air cleaning system is checked on site by the employers' liability insurance association (SVLFG), the German Testing and Certification Body for the Agricultural and Forestry Industry (DPLF) or by suitable experts. All relevant guidelines and standards are taken into consideration in this process. A final report or certificate is issued once the occupational safety check has been completed and all safety defects have been eliminated.

F) Compliance with statutory regulations and review of environmentally relevant aspects

The residues incurred in the system are measured and information on their disposal is provided. The handling of chemicals as well as the use and disposal of the overall system and parts of the system are additionally dealt with.

Compliance with relevant rules and regulations (e.g. German Water Resources Act (WHG), German Ordinances on Facilities for Handling Substances Hazardous to Water (VAwS / AwSV), German Fertiliser Ordinance (DüMV)) is checked.

G) Appraisal of the measurements

The measurements are appraised by the DLG Test Commission. The independent and expert Test Commission works on a voluntary basis. External measurement laboratories that are involved provide DLG with their test report and all of the measurement data. The data are processed and transferred to the Test Commission for assessment.

On successful completion, DLG produces a test report containing a summary of the measured values as well as the assessment based on the measured values according to the requirements from Table 1. The report additionally contains an evaluation of the electronic operation log with corresponding data concerning substance consumptions and operating stability (e.g. pH value and conductivity progressions for exhaust air scrubbers). This test report is published in German and possibly in an additional language, and can be downloaded free of charge by clicking on the following link:

<https://www.dlg.org/de/landwirtschaft/tests/suche-nach-pruefberichten/?unterkategorie=95&page=1&pruefgebiet=3>