# Information Sheet

# Stack Emission Proficiency Test Odour

## 1. Location

Hessisches Landesamt für Naturschutz, Umwelt und Geologie
*(Hessian Agency for Nature Conservation, Environment and Geology)*

Dezernat I3 – Luftreinhaltung: Emissionen
*(Department I3 – Air Pollution Control: Emission)*

HLNUG – I3
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- GERMANY -

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**Please note:** The sampling takes place on the 1st and 3rd floor of the HLNUG building. A lift is not available.

## 2. Contact

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## 3. Participants

HLNUG's stack emission proficiency tests were designed for laboratories that are authorised to perform measurements in accordance with §29b BImSchG (Federal Immission Control Act), as well as applicants for authorisation in accordance with BImSchG. Nevertheless, other laboratories, manufacturers of equipment, industrial departments engaged in emission monitoring etc. are welcome to participate, too.

**Please note:** Due to the limited space around the flue duct, without prior affirmation by the organiser for each laboratory only two people can participate in the sampling on site.

The total number of participating laboratories per round is limited to 10.

## 4. Task

The proficiency test programme simulates installations with predominantly constant operating conditions with regard to the emitted odour concentrations, at which at least three individual measurements are required according to "TA Luft" (Technical Instructions on Air Quality Control) section 5.3.2.2. The ability to correctly determine odour concentrations in emissions using the overall procedure of sampling and olfactometry is considered directly relevant for an authorisation according to §29b BImSchG.

## 5. Execution of measurements

### 5.1. Measurement rooms and cross sections

The measurements take place on the 1st and the 3rd floor of the HLNUG building (room 130, and 371, respectively). All sampling ports there have an inlet section (vertical, straight flue duct) of at least 6.5 m. To carry out the proficiency test, sampling ports conforming to standard ISO 228 are available in the following sizes:

**Table 1:** Available sampling ports.

| floor | 3" internal thread (G3) | 2" internal thread (G2) |
|---|---|---|
| 1st floor | 8 | 4 |
| 3rd floor | 6 | 7 |

The allocation of the sampling ports to the participants is determined by HLNUG staff on site. The sampling probes used by the participants must be adapted to the inner diameter of the system of 40 cm.

### 5.2. Determination of gas flow conditions

The ESA is operated in fresh air mode with preheating and, if necessary, humidification of the outside air. The system parameters are - as far as possible - kept constant during a measuring day. The gas flow conditions are selected so that droplet formation in the stack is prevented. During the proficiency test, the following parameters of gas flow conditions shall be measured for each test day, conforming to EN 15259:

**Table 2:** Value ranges for gas flow conditions and specified rounding of the measured values.

| No. (*k*) | component | value range | decimal places |
|---|---|---|---|
| R1 | volume flow | 2000 – 6000 $m^3$/h (sc, dry) | 0 |
| R2 | mean flow velocity | 4 – 15 m/s (oc, wet) | 2 |
| R3 | temperature | 20 – 50 °C | 1 |
| R4 | water vapour concentration | 0 – 50 g/$m^3$ (sc, dry) | 2 |
| R5 | static pressure | 0 – 10 hPa | 2 |

sc, dry: standard conditions, dry; oc, wet: operating conditions, wet.

When measuring the gas flow conditions, the participants shall use the measurement methods normally used by them on comparable installations.

## 5.3. Performance of samplings

- Each participant carries out the determination of the odour concentrations in accordance with EN 15259 and the standards listed in Table 3 in their current version. For the application of other sampling or analysis methods in the case of participations in connection with the 41st BImSchV, a proof of equivalence in accordance with EN 14793 must be provided.
- Sampling is carried out simultaneously by all participants, conforming to the following standards:

**Table 3:** Measuring methods and concentration ranges for odour measurements.

| No. ($k$) | component | compulsory method | concentration range | criterion for proficiency assessment $\sigma_k$ |
|---|---|---|---|---|
| O1 | *n*-butanol | EN 13725, VDI 3880 and VDI 3884 part 1 | 50 to 50,000 $ou_E/m^3$ | 0.10 |
| O2 | depending on the proficiency test changing substances or substance mixtures | | | 0.16 |
| O3 | | | | |
| O4 | | | | |

- The procedure used by the participant in the proficiency test must correspond as far as possible to the standard procedure routinely used at comparable real plants. For organisational reasons, only the following deviations are necessary or permissible:
  - Reduction of the sampling time from 30 to 10 minutes
  - Olfactometry is carried out in an odour room near the sampling site that is not normally used by the laboratory
- The participants in the proficiency test must carry out the sampling and olfactometry with their own measuring equipment.
- Transport of samples and olfactometry are organised by the participants.
- The sampling equipment must allow for measurements in flue gases with a high water vapour content.
- For each component, 3 consecutive measurements are carried out at comparable concentrations. The duration of each of the 3 samplings is 10 minutes.
- Concentrations in the range of 50 $ou_E/m^3$ to 50,000 $ou_E/m^3$ are aimed for. These limits are to be understood as guide values. For components whose odour threshold value is calculated from the results of the current proficiency test after the measurements have been carried out, the target value may also lie outside this range.
- Sampling protocols, result matrices and other relevant records of the participant for the measurements carried out must be submitted to HLNUG at the end of the measurement day – if possible, as a digital copy.
  The handover is possible e.g., by email (pt@hlnug.hessen.de) or via USB data carrier. If recordings are only available in paper form, copies will be made by HLNUG.

### 5.4. Odour room

The odour samples are usually analysed on site in Kassel. A mobile odour room or another suitable room (e.g. meeting room in a hotel) can be used for this purpose. If a room at HLNUG is required as odour room, this must be indicated together with the registration for the proficiency testing scheme. HLNUG will allocate the available rooms. For a prior inspection of the rooms used at HLNUG, an appointment can be arranged with HLNUG using the contact details above.

In any case, the participant is responsible for ensuring that the standardised requirements for the odour room used are met.

Participants who do not work in accordance with VDI 3880 and therefore do not have to complete the olfactometry within 6 hours of sampling can also transport the samples to their own laboratory and analyse them within 30 hours in accordance with EN 13725. However, as this procedure differs significantly from that of the other participants, there are consequences for the results analysis (see below).

## 6. Submission of results

### 6.1. Odour concentrations

All measurement results of odour measurements must be given in $ou_E/m^3$ as integers (whole numbers) and in relation to the olfactory standard conditions, wet (1013.25 hPa and 293.15 K).

The results must be sent by e-mail to the following address no later than **one week** after the day of sampling:

pt@hlnug.hessen.de

For this purpose, the measured values shall be entered in a MS Excel file, which can be downloaded from the HLNUG website at

https://pt.hlnug.de

Results submitted at a later date will not be considered unless HLNUG is responsible for the late receipt. In this case, the participation is considered ‘failed’.

Each participant can only submit one result per measurement and component. The measured values submitted by the participants are checked for plausibility by the HLNUG using the data collected during the proficiency test. If this plausibility check reveals doubts about the determination of measured values in conformity with the respective standards, the participant concerned will be asked to provide a detailed explanation of the determination of results. If a participant is not able, upon request, to reconcile the submitted measurement results in a comprehensible and standard-compliant manner with the raw data and other records produced within the framework of the proficiency test, the components concerned will be assessed as "not evaluated ", in deviation from section 8. In this case, a corresponding note will be added to the communication of results. An exchange of results among participants before the deadline for submission of the measurement results or other collusive behaviour is not permitted. In the event of a violation of this regulation, all affected components will also be assessed as "not evaluated" and a corresponding note will be added to the communication of results.

Communication of the result evaluation to the participants in the proficiency test is made in the form of an overall summary no later than 6 weeks after expiry of the deadline for submission of the participants' measurement results.

The proficiency test is also open to participants who do not complete the olfactometry within 6 hours after the end of sampling. Please note, however, that in this case the overall result of the proficiency test participation is "failed (incomplete participation)" with regard to the 41st BImSchV, regardless of the results of the individual components. If the olfactometry was not carried out within 6 hours in accordance with VDI 3880, then the participation clearly deviates from the specifications acclaimed by the Conference of Ministers for Environment (UMK) and the Federation/Federal States Working Group on Immission Protection (LAI). As a result, participation under these conditions does not meet the requirements of §16 IV 7a of the 41st BImSchV and therefore cannot be used, for example, as proof of competence for emission measurements within the meaning of §29b BImSchG.

### 6.2. Gas flow conditions

The measurement results for the gas flow conditions shall be reported in the units and rounded to the number of decimal places specified in Table 2.

The submission deadline for the proficiency test part 'gas flow conditions' is the same as the deadline for the submission of the measurement results for the odour concentrations. If no measurement results are submitted, the proficiency test part 'gas flow conditions' is assessed as "no participation".

## 7. Assessment of single measurement results

### 7.1. Odour concentrations

The evaluation of the proficiency test is carried out on the basis of the z-score procedure, using logarithmic values.

For the measurement value $x_{ik}$, which is for sampling number $i$ of component number $k$, a z-score value $z_{ik}$ is determined:

$$z_{ik} = \frac{1}{\sigma_k} \log_{10}\left(\frac{x_{ik}}{X_{ik}}\right)$$

In this equation, $X_{ik}$ is the assigned value of the measurement, and $\sigma_k$ is the precision criterion (criterion for proficiency assessment) for component $k$.

The assigned value is calculated from the mass concentration $c_{ik}$ and the odour threshold $c_{0,k}$ of the component:

$$X_{ik} = \frac{c_{ik}}{c_{0,k}} \mathrm{ou_E/m^3}$$

The dosed mass concentration $c_{ik}$ is determined for each measurement based on the measurement data of the dosing device and the volume flow. The odour threshold $c_{0,k}$ of $n$-butanol

is $c_0$ = 123 µg/m$^3$. The thresholds of all other components are deduced from proficiency test results according to the following procedure:

a) A consensus value is calculated from the measurement results reported by at least 20 participants in at least two different proficiency tests previously run by HLNUG. Here, solely results of participants are taken into account, who participated regularly (olfactometry conforming to VDI 3880) and achieved the result "passed" for the component *n*-butanol in the respective proficiency test. The consensus value is obtained by the robust mean of the logarithmic values according to standard ISO 13528 (algorithm A) and is updated on a regular basis by including new results. This calculation is restricted to measurements of the past five years as long as the above-mentioned requirements are met.

b) If not enough measurement results of former proficiency tests are available to determine the consensus value of a component by means of the procedure described under a), an alternative method is used: Here, the consensus value of a component offered during a proficiency test is subsequently calculated from the participants' measurement results. Provided that the sampling was carried out within 14 days, results of several proficiency tests are taken into account. Solely results of participants are considered, who participated regularly (olfactometry conforming to VDI 3880) and achieved the result "passed" for the component *n*-butanol in the respective proficiency test. The consensus value is obtained by the robust mean of the logarithmic values according to standard ISO 13528 (algorithm A). If less than nine measurement results for one particular component are available that fulfil the above-mentioned criteria, neither a z-score-based evaluation nor a performance rating are possible.

The precision criterion for the component *n*-butanol is:

$$\sigma_k = 0.10$$

For all other components, the precision criterion is generally:

$$\sigma_k = 0.16$$

The precision criterion is always 1/10 of the deviation from the assigned value in $dB_{od}$ (odour decibels), which leads to a z-score of 1. A z-score value of ±3.0 is therefore achieved for *n*-butanol with a deviation of the measured value from the assigned value of ±3.0 $dB_{od}$, for other components with a deviation of ±4.8 $dB_{od}$.

If the relative uncertainty of the assigned value $u_k$ calculated according to ISO 13528 for a component (except *n*-butanol) results in a value with which the condition

$$\sigma_k \geq \frac{1}{0.3}\log_{10}(1 + u_k)$$

is not fulfilled, the precision criterion for the component concerned is adjusted in accordance with ISO 13528. In doing so, $\sigma_k$ is recalculated precisely to two decimal places, so that the condition is fulfilled. Participants are informed about the increase of the precision criterion at the latest when the evaluation is communicated by HLNUG.

### 7.2. Gas flow conditions

To evaluate the measurement results for the volume flow (component R1), a z-score value $z_k$ is determined for the measured value of the $k$-th component, $x_k$:

$$z_k = \frac{x_k - X_k}{\sigma_k}$$

Here $X_k$ is the assigned value of the corresponding measurement and $\sigma_k$ is the criterion for performance evaluation. The assigned value is determined by the continuous measurement devices of the HLNUG. The criterion for performance evaluation is 140 $m^3$/h (standard conditions, dry) for component R1. No z-scores are calculated for components R2 to R5. Here instead, the deviations of the participants' measured values from the assigned values are compared informatively with the usual standard deviation for these measurements. For this purpose, the quotient is calculated from the deviation of the participants' measured values from the assigned values and the usual standard deviation for the measured parameter in question. The corresponding comparison values are shown in Table 4.

**Table 4:** Usual standard deviations for gas flow conditions.

| No. ($k$) | component | usual standard deviation $\sigma_k$ |
|---|---|---|
| R2 | mean flow velocity | 0.30 m/s (oc, wet) |
| R3 | temperature | 0.9 °C |
| R4 | water vapour concentration | 0.74 g/$m^3$ (sc, dry) |
| R5 | static pressure | 0.21 hPa |

sc, dry: standard conditions, dry; oc, wet: operating conditions, wet.

### 7.3. Interpretation of z-score values

After normalisation to the criteria for performance evaluation, the following scheme applies to the interpretation of all determined z-score values:

$|z_{ijk}| \leq 2$ satisfactory performance (no signal)

$2 < |z_{ijk}| < 3$ questionable performance (warning signal)

$|z_{ijk}| \geq 3$ unsatisfactory performance (action signal)

As a general rule, every measurement leading to a result that was evaluated with a z-score of more than two should be investigated to identify the reasons for the deviation.

## 8. Evaluation of components

### 8.1. Odour concentrations

For the evaluation of a component, the mean value $z_k$ of the absolute values of the $n$ z-scores (usually $n$ = 3) of each component is calculated:

$$z_k = \frac{1}{n}\sum_{i=1}^{n} |z_{ik}|$$

A component was determined successfully, if

$$z_k < 3$$

is fulfilled. In this case, the component is rated “passed”. If this criterion is not met or if no measurement result was submitted in due time, the component is rated “failed”.

### 8.2. Gas flow conditions

The component “volume flow” is evaluated as "passed" if the condition

$$|z_k| < 3$$

is fulfilled, otherwise the component is evaluated as "failed". If no measured values were submitted, the component is indicated as "no participation".

## 9. Overall evaluation of the proficiency test

### 9.1. Odour proficiency test

If all components O1 – O4 were assessed as "passed", the participant receives an overall assessment of "passed" for their participation in the proficiency test. If at least one of the components O1 – O4 was assessed as "failed", the participant receives the overall assessment "failed" for the participation in the proficiency test. If at least one of the components O1 – O4 was not taken part in or for other reasons no assessment could be made for one of these components, while the other components were assessed as "passed", the participant receives the overall assessment "failed (incomplete participation)" for the participation in the proficiency test. The same applies, if the components O1 – O4 were assessed as “passed”, but the olfactometry was not performed within 6 h after sampling.

If applicable, the significance of this evaluation is pointed out with reference to §16 IV 7a of the 41. BImSchV (41st Federal Immission Control Ordinance).

### 9.2. Gas flow conditions

The proficiency test part “gas flow conditions” is evaluated as "passed" if component R1 was evaluated as "passed". If component R1 was evaluated as "failed", this proficiency test part is evaluated as "failed". If component R1 was not participated in, the proficiency test part "gas flow conditions" is indicated as "not evaluated".

## 10. Communication of the evaluation

The assessment results are communicated to the participants in the proficiency test in the form of an overall summary by no later than 6 weeks after the deadline for submission of the participants' results. In the communication of results, the personnel involved in the measurements and sampling at ESA shall be mentioned by name. Also included is an estimate of the measurement uncertainty calculated according to EN ISO 20988 type A5 case 2.

The obligation of the authorised measuring bodies to inform the authority responsible for their authorisation directly about the results of the proficiency test (§16 IV No. 7 of the 41. BImSchV) is pointed out.

In addition, the results of the proficiency tests of one year are summarised in an annual report, whereby the participants are pseudonymised.

## 11. Theory test

On the first day of the odour proficiency test, a 30-minute written test is conducted. The contents of this test are the requirements of the standards and guidelines applied in the proficiency test. As this theory test is currently offered only in German, interested participants are asked to refer to the German version of this document for details.

Participation in the theory test is not mandatory.

## 12. Objections and complains

Objections and complaints should be addressed to the organiser of the proficiency testing scheme, if they relate to the invitation, the conduct of the proficiency testing scheme, the communication of results, or the results themselves. Various aspects of the proficiency testing programme may be subcontracted at times. In case of subcontracting, this is done to a competent subcontractor, for whose work the HLNUG is responsible.

Objections and complaints should be addressed to the authority responsible for authorisation under national law, insofar as they relate to measures derived from the results (e.g. a request to repeat the proficiency test, withdrawal of the authorisation, etc.).

The time limits for objections are regulated in the respective notices and notifications.

## 13. Costs

The participation fee is charged in accordance with the currently valid administrative cost regulations (Verwaltungskostenordnung) for the division of the Hessian Ministry of Agriculture and Environment, Viticulture, Forestry, Hunting and Community (Hessisches Ministerium für Landwirtschaft und Umwelt, Weinbau, Forsten, Jagd und Heimat; VwKostO-MLU, for the full text see: www.rv.hessenrecht.hessen.de). Upon confirmation of your participation, you will receive a notification of prepayment, payable before the start of the proficiency test. If a short-term cancellation of the proficiency test by HLNUG should be necessary for important reasons (e.g. facilities or personnel shortage, etc.), the prospective proficiency test participant has no claim to compensation except reimbursement of the participation fee.

## 14. Timetable

On the next page you can find the timetable for the proficiency test. A prerequisite for the observance of the specified times is, among other things, the smooth and swift performance of the measurements by the participants. The organisers cannot therefore guarantee that the times will be adhered to. Depending on the actual course of the performance of the individual items, there may be delays in the schedule. In the event of deliberate disruptions to the schedule by individual participants, they may be excluded from the proficiency test.

# Timetable odour proficiency test

**Day 1**

| | |
|---|---|
| **from 13:00** | Arrival of participants and set-up of sampling equipment, allocation of odour rooms (where applicable) |
| **15:00** | Welcome and introduction (**room 258**, not mandatory), followed by theory test (one person per laboratory, in German, also not mandatory) |
| **until 17:00** | Completion of preparations in the measuring rooms and HLNUG odour rooms |

**Day 2**

| | |
|---|---|
| **08:00** | Measurement of gas flow conditions part I (pressure, temperature, humidity)<br>*(This part of the gas flow conditions is measured by all participants at the same time)* |
| **08:30** | 12 samplings in accordance with EN 13725 |
| **12:30** | Lunch break |
| **13:00** | Measurement of gas flow conditions part II (volume flow profile)<br>*(This part of the gas flow conditions is measured by one participant after another)* |
| **until 16:00** | removal of measuring devices at the ESA |
| **until 19:00** | Submission of raw data and protocols from the olfactometry (for all participants), removal of measuring devices from HLNUG odour rooms. |