

Odour Regulation in Germany – an improved system including odour intensity, hedonic tone and odour annoyance

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Abstract

For odour regulation in Germany the Guideline on Odour in ambient Air GOAA has been in use for many years. The main parameter the odour regulation authority has to take into account is the odour frequency expressed as odour hours per year. In the Guideline limit values are given for the maximum odour frequency per year.

These limit values are based on investigations in the field in which significant relationships between odour impact and odour annoyance were found. In these investigations odour intensity did not yield a better description of the annoyance degree of residents. The hedonic tone was not mentioned.

In a new research project the influence of odour intensity and hedonic tone in addition to odour frequency has been assessed. As a consequence of this investigation there is no need to modify the fundamental system of data acquisition, analysis and evaluation of the GOAA but the results show that in some cases (pleasant odours) it is necessary to include hedonic tone. Therefore hedonic tone in the case of pleasant odours and a reliable and valid method to evaluate hedonic tone in the field is included in the GOAA.

Keywords

Odour regulation; annoyance; immission limit values; odour impact; odour frequency; Guideline on Odour in Ambient Air

1. Legal framework

The legal basis for any requirement with respect to ambient air quality is the German Federal Protection Act for Ambient Air (1974/1990/2002) [1] and the Technical Instruction on Air Quality Control (2002) [2]. According to § 3 Federal Protection Act for Ambient Air [1] odours caused by installations are treated as a nuisance. The problem is to find out whether a nuisance has to be considered as significant. If odour emissions from installations occur this question has to be answered in every licensing or surveillance procedure. In cases of urban development planning evaluations of odours in ambient air are also required.

The Guideline on Odour in Ambient Air GOAA (1994, revised version 1999; in former times also called Directive on Odour in Ambient Air) [3] is the odour regulation instrument in Germany in nearly all these cases. In this Guideline, a complete system is designed, beginning with measurement methods of the initial odour impact, calculation of the additional odour impact and the total impact and concluding with ambient air quality requirements expressed as immission* limit values in terms of maximum permitted odour frequency in ambient air in certain areas ([4], [5]).

**(The word „immission“ is used in the sense of influence of air pollutants, in this case odour, on humans. This establishes an active view of air pollutants influencing receptors, in contrast to the passive view of receptors being exposed to air pollutants. If we neglect this more semantic difference, “immission” can be interpreted as exposure.)*

2. The System of data acquisition, analysis and evaluation

The main objective of the odour measurements mentioned in the Guideline on Odour in Ambient Air GOAA [3] are recognizable odours occurring in a certain area. A distinct difference is made between ubiquitous odours like traffic exhausts or smelling vegetation on the one hand and recognizable and distinguishable odours caused by plants on the other hand. Since more than 15 years the relevant parameter for odour assessment has been the amount of time per year in which odour occurs (odour frequency = odour impact) [6].

There are two basic methods given in the GOAA for determining odour frequency (odour impact) in ambient air: first, field measurements with panels and second, dispersion modelling.

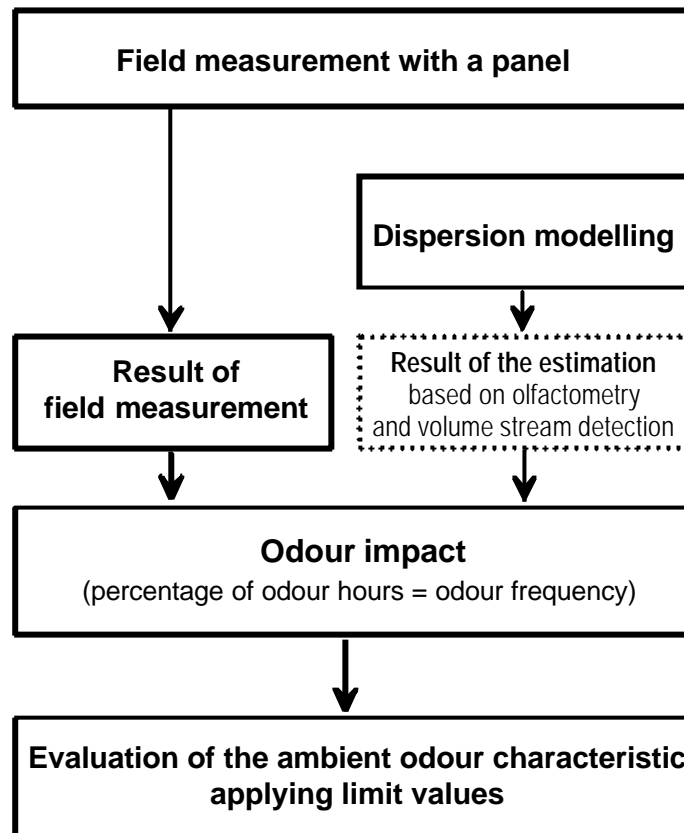
Dispersion modelling includes olfactometric emission measurements, volume stream determination and determination of meteorological conditions. The objective is to calculate recognizable odours expressed as odour frequency per year for certain areas. It depends on the dispersion model and the associated parameters how accurate the results are in line with the real conditions on site. The typical field of application of dispersion modelling is the estimation of odour frequencies probably caused by plants to be built (additional odour impact). If the odour emission rate is known, it is also applied for estimating the initial odour impact. But in any case, results of dispersion modelling are only an estimation.

Contrary to this, the objective of field measurements carried out by panels is to record odours that are immediately recognizable under real field conditions. The odour in ambient air is determined by systematic field measurements using trained and selected panel members according to Guideline VDI 3940 [7]. Thus the result of field measurements directly depends on the odour impact in a certain area expressed as odour frequency and represents what residents would perceive. These measurements are definitely more advantageous than other methods if for example there are more than one existing emission source and/or fugitive sources, causing perhaps a lot of complaints. Also, if the frequency distribution of dispersion categories for the location isn't available field measurements are advantageous.

In Figure 1, an overview of the system of data acquisition, analysis and evaluation is given based on the GOAA. The result of these methods is the odour impact. In the case of dispersion modelling, it is an estimated value, in the case of the field odour measurements it is a result of an immediate and precise recording. In any field of application, the result of field measurements carried out by panels is the target value for all other methods. To carry out field measurements is the only possibility to investigate the real odour impact under the existing conditions.

The integration of the evaluation criteria in Figure 1 points out the close relationship between the two different measurement methods, their results and the odour impact on the one hand and the evaluation procedure and the limit values on the other hand. As established in the GOAA the limit values are only to be applied in connection with the methods mentioned. This particular procedure requires all other approaches to present proof of reproducibility.

Figure 1: System of data acquisition, analysis and evaluation based on the Guideline on Odour in Ambient Air GOAA



However, field measurements are not as common as dispersion modelling as table 1 shows. There are different reasons for this; one is the duration of half a year for field measurements. Others are cost or planning aspects. Depending on the size of the assessment area costs for field measurements vary between 9.000 and 14.000 Euro.

Table 1: Methods in use to determine odour impact in Germany

Used method	Percentage of appliance
Dispersion modelling	approx. 80%
Field measurements with panels	approx. 15%
Simplifying methods	approx. 5%

3. Odour limit values

In the GOAA quality requirements are fixed as immission limit values as given in Table 2. These values limit the amount of recognizable odour related to installations. A difference is made between two types of areas, residential or mixed areas on the one hand and trade or industrial zones on the other hand.

Table 2: Limit values for odour in ambient air in different areas.

Residential, mixed area		Trade, industrial zones	
relative frequency	%	relative frequency	%
0.10	10	0.15	15

These limit values were developed on the basis of investigations [8] [9] in which the initial odour impact measured as odour frequency [7] and the degree of odour annoyance of residents assessed by questionnaires according to Guideline VDI 3883 Part 1 [10] were correlated [11]. As a result odour frequencies between 10% and 20% were found to be the critical range where a significant nuisance according to the definition of the German Federal Protection Act for Ambient Air is recognised.

4. Odour intensity and hedonic tone

Furthermore the investigations [8] and [9] showed that increasing odour intensities did not necessarily lead to an increasing degree of annoyance. It was sufficient for the description of the odour situation on site (the odour impact) to determine recognizable odours expressed as odour frequencies [12]. The hedonic tone of odours wasn't taken into account in these investigations.

In odour regulation in Germany hedonic tone of odour in terms of pleasant and unpleasant generally didn't appear as a relevant parameter for the evaluation procedure. However, there are a few hints in literature that odour intensity and hedonic tone play a role in odour annoyance. But there was no standardised method to measure these parameters in ambient air in residential areas where they may cause complaints. Also there was no elaborated system which could be used for regulation.

Therefore the Ministry of the Environment, Conservation, Agriculture and Consumer Protection of the State of North Rhine-Westphalia, Ministries of the Environment and Traffic of the state Baden-Württemberg and the German Chemical Industry Association (VCI) have assigned a scientific investigation with the subject INVESTIGATIONS ON THE EFFECT OF ODOUR INTENSITY AND HEDONIC TONE ON THE ANNOYANCE DEGREE OF RESIDENTS in 1999.

The project started in 1998 and was finished in 2003. The investigation was carried out in the vicinity of six installations, which cause pleasant, neutral and unpleasant odours in residential areas. In the investigation odour impact was measured by field inspections using trained and selected panel members [7] and in some cases by dispersion modelling. The assessment of odour annoyance was carried out by means of direct interviews using a modified questionnaire with respect to Guideline VDI 3883 Part 1 [10] covering odour annoyance, symptom reporting and relevant covariates. For more details in connection with the assessment of odour annoyance see [11] and [13].

The main results with reference to [13], [14] and [15] are:

- A new method to measure odour intensity and hedonic tone in the field with data records form was developed and validated. With this method reliable and reproducible results are obtained.
- The parameter odour frequency based on the system of the GOAA is suitable and sufficient to predict odour annoyance caused by unpleasant/neutral odours.
- In the case of pleasant odours hedonic tone has an abundantly clear effect on the dose-response-relationship between odour frequency (odour impact) and annoyance. Pleasant odours have a significant lower annoyance potential than unpleasant/neutral odours.
- No additional influence on this relationship has the odour intensity. If odours are recognizable they could cause annoyance.

As a consequence of this investigation there is no need to modify the fundamental system of data acquisition, analysis and evaluation based on the GOAA but the results show that in the case of pleasant odours it is necessary to include hedonic tone. Therefore a working group of authorities responsible for odour regulation started to revise the guideline with the objective

- to include hedonic tone in the cases of pleasant odours in the GOAA and

- to describe a reliable and valid method in the GOAA to evaluate hedonic tone in the field.

By the way also the references to the new Technical Instruction on Air Quality Control (2002) [2] are updated. This also includes a new dispersion model (AUSTAL2000-Odour) which was developed according to the Technical Instruction on Air Quality Control (2000) [16].

The method how to decide whether an installation emits unambiguous pleasant odours is based on polarity profiles which will be assessed by a panel in the field. If the decision is made that an installation causes pleasant odours the odour impact is multiplied by 0.5 before it will be compared with the limit values of the GOAA.

On the 21th of September the new Version of the GOAA passed the Länder Committee of Immission Control (LAI). Now it is up to the German Länder to use the revised version of the GOAA for odour regulation.

5. Conclusion

- The Guideline on Odour in Ambient Air GOAA is the odour regulation instrument in Germany.
- In the GOAA a complete system is designed, beginning with measurement methods of the initial odour impact and calculation of the additional odour impact and the total impact and concluding with ambient air quality requirements expressed as immission limit values in terms of maximum permitted odour frequency in ambient air in certain areas.
- The immission limit values of the GOAA were developed on the basis of investigations in which the odour impact and the degree of odour annoyance of residents were correlated. As a result odour limit values are fixed to avoid significant nuisance according to the definition of the German Federal Protection Act for Ambient Air.
- As a consequence of a new investigation there is no need to modify the fundamental system of data acquisition, analysis and evaluation stated in the GOAA but the results show that in some cases it is necessary to include hedonic tone.
- The GOAA (Version 21.09.2004) includes hedonic tone in the cases of pleasant odours and a reliable and valid method to evaluate hedonic tone.

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