

On the accuracy of the measured odour impact by field inspection (grid method) specific for every single grid. An additional worthwhile information to evaluate the data set.

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In the German VDI Guideline 3940 Part 1 (VDI, 2006) there is described a method to determine the odour impact by using field inspections in areas. The main point of this method is that the determination of the odour measurement is independent of specific sources. The investigation area should be covered with a grid of mostly rectangular single squares. The VDI Guideline 3940 Part 1 (VDI, 2006) defines in detail how to undertake these measurements. An information to the accuracy is given only in general but not specific to the actual measurement at single square itself.

This was and is still sometimes a reason why outside of Germany these measurements are often discussed controversy.

For this reason a new system to determine the accuracy of the so called German grid method had been developed. The system offers not only the mean value of positive counted measurement intervals, which leads to the achieved percentage of odour hours per year (ref. "Guideline on Odour in Ambient Air, GOAA"). Now it is possible to have the information, how many odour impressions around (above and below) the counting levels (odour hour criteria) were detected.

Two actual grid measurements were analyzed according to this new system. The results show clearly the advantages of this new system and the achieved additional worthwhile information specific to different sources, which were investigated by the field inspection.

1. The System of VDI 3940 Part1

In the determination of odorant pollution according to VDI Guideline 3940 Part 1 (VDI, 2006) and its assessment and in accordance with Odorant Emission Guideline (GOAA, 2008), experience shows that evaluation of odour impact can be done successfully.

First one has to define the evaluation area and the measurement points where the odour impact should be investigated. Figure 1-1 shows an impression of an area and the points of the grid measurement. Within the evaluation area the evaluation grid is defined as a rectangular grid with four measurement points. The side length of these grids are usually 250 m x 250 m. Depending of the structure of the potential emitting sources, smaller grid can be chosen, down to 50 m x 50 m. Figure 1-2 shows an evaluation grid.

As a rule, the odour ambient air quality is to be measured at the height of approximately 1.5 m above ground level and at a lateral distance of more than 1.5 m from the next located building.

The chosen measuring period shall be representative for a total year. Normally the period is $\frac{1}{2}$ year. The measurements must be done together with the measurement of wind direction, wind speed and atmospheric turbulence during that period. The use of an ultra sonic anemometer is recommended.

In order to obtain representative results, the measurements must be distributed over 24 h a day and all types of days (working days, Saturday and Sunday). For this reason it is necessary to establish a distinct time table for the measurements.

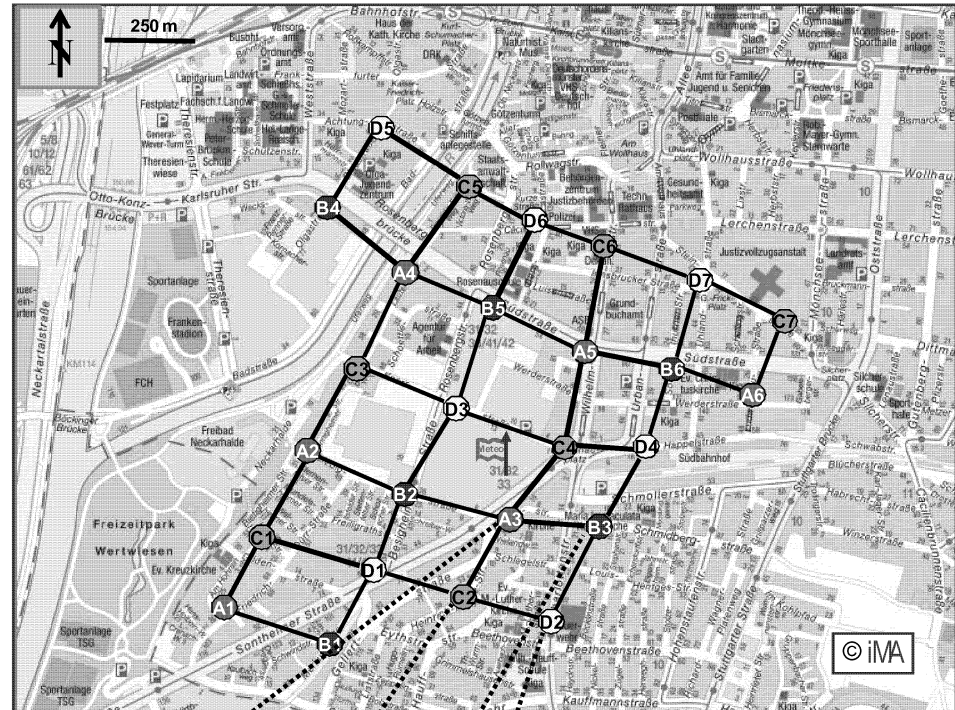


Figure 1-1: Map of a typical grid measurement. One grid is defined by A_i , B_j , C_k and D_l

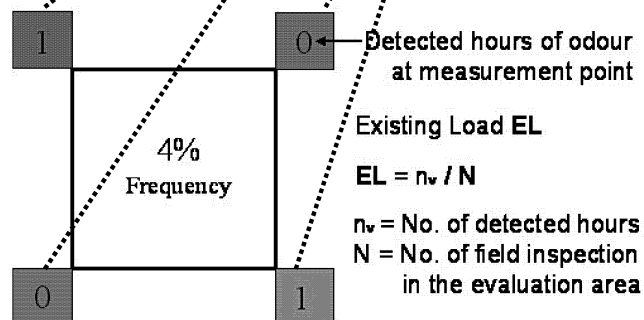


Figure 1-2: Evaluation square for detection of odour impact by field inspection along to VDI 3940 Part 1

According to the definition, a single measurement is the measurement of odour impact by an assessor at a single measurement point during a defined measurement cycle of 10 min. A measurement cycle of at least ten minutes is required in order to obtain a representative statement with at least 80 % certainty on the odour situation within one hour (Kost et al., 1991).

During a measurement cycle of 10 min an assessor sniffs the ambient air every ten seconds and records the identified odour quality. After the ten minute measurement cycle the assessor has assessed 60 odour samples. The measurement cycle is a counting odour hour (GIRL, 2008), if the surveyed percentage odour time reaches or exceeds 10 % of the measured cycle time.

That means, 6 or more positive odour signals of a distinct quality lead to one odour hour and 5 or less positive odour signals of a distinct quality are not a counting as an odour hour. Therefore it is very important, whether an assessor assesses 3, 4, 5 or 6, 7, 8 positive odour signals during the measurement cycle of ten minutes. On the other hand doesn't makes a difference, whether an assessor assesses 15 or 45 positive odour signals, because both counts as only one single odour hour.

2. Accuracy of field inspection by grid measurement

The accuracy of the results of grid field inspections depends on the range of variation of the final result, i.e. the odour hour frequency as a percentage of annual hours for a defined assessed area. An extended measurement uncertainty of two odour hours has been calculated by means of repeat determinations (Müller et al. 2008). This procedure is highly elaborate, however, and thus reserved for exemplary investigations. One way of estimating the variation range with an acceptable degree of effort is with evaluations based on different odour hour shares.

While the accuracy of a single signal cannot be defined as standard for every single measurement, evaluations with an acceptable degree of effort are on the other hand possible on the basis of odour hour shares, from which information the certainty of a result can be directly derived.

The evaluations comprise the following:

1. Averaging of the intervals per measurement cycle (10 min) at all measurement points of an assessment square that resulted in the counting of an odour hour.
2. Calculation of the lower variation range (Oh_l ; odour hour lower) of the measured odour hour frequency per assessment square with the exclusion of the measurement cycles with an odour hour share of 6, 7 and 8 intervals with odour.
3. Calculation of the higher variation range (Oh_h) of the measured odour hour frequency per assessment square with the inclusion of the measurement cycles with an odour hour share of 3, 4 and 5 intervals with odour.

A first step to this systematic was given in 2009 (Kost et al. 2009). A specific analysis of field measurement showed that detailed information to grid measurements can be achieved, if one takes into account only just and just-not the positive signals of measurement cycles per square.

An example of an evaluation of a field inspection is given in Table 1-1.

Table 2-1: Result of grid measurements and accuracy per grid

Square	Odour hours			Frequency of odour hours			Mean
No.	N _{Ohl} (>2<6)	N (>5)	N _{Ohh} (>5<9)	F _{Ohl} %	F %	F _{Ohh} %	M(N _{max} 60)
1	4	8	3	8	16	6	22
2	3	12	2	6	24	4	26
3	4	9	1	8	18	2	22
4	1	3	0	2	6	0	14
5	2	20	3	4	39	6	27
6	2	19	4	4	37	8	26
7	1	9	1	2	18	2	20
8	2	16	3	4	31	6	27
9	1	18	5	2	35	10	20
10	2	12	2	4	24	4	20
11	1	5	2	2	10	4	18
12	3	7	3	6	14	6	28
13	2	11	5	4	22	10	21
14	4	8	3	8	16	6	15
15	4	3	1	8	6	2	17
16	1	3	0	2	6	0	15
17	1	1	0	2	2	0	15
18	0	1	1	0	2	2	6
19	0	1	1	0	2	2	6
20	0	0	0	0	0	0	---

As seen from table 1-1 for each square it is possible to make transparent how reliable the odour signal was measured. In the main column the counted “Odour hours” are documented together with their possible uncertainty. One can see how many potential odour hours only just were observed and had been counted by the assessors and how many not. For the evaluation with limit values now it is possible to show, how sure limit values e.g. of the (GOOA, 2008) will be exceeded or not.

In combination with the information of the mean value per square is possible intermitting emissions sources of complex source groups can become aware because they normally can be observed with a low frequency but with high mean.

Figure 2-1 gives an impression how a result of a grid shall be illustrated in future.

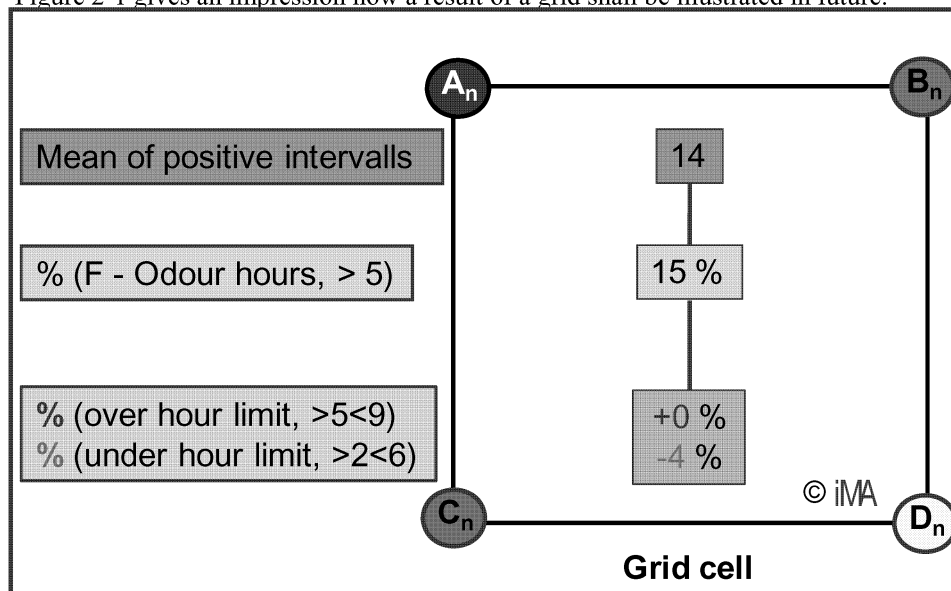


Figure 2-1: Example for documentation a result of measured odour impact by field inspection (grid method) specific for every single grid.

3. Conclusion

In this paper a method was presented, which can help to have more transparency in data of grid measurements. A method was developed to give information how accurate a odour the frequency per grid was measured. In the past and now different analysis showed that the acceptance is much higher by authority when data sets including the information of accuracy are provided. This happened especially in that case where the field measurements by the grid method were criticized.

Last but not least this method is one brick more in the wall of quality assurance and will be one part of a planned European Guideline dealing with "Air Quality – Determination of odour exposure in ambient air by using field inspection - Grid method".

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