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Explanations to the draft of the new guideline for livestock farming VDI 3474

In March 2001 the draft of the new guideline for livestock farming VDI 3474 was issued as a Green Paper. The respective distances now depend more strongly on the local conditions. More emitting sources are taken account, as is wind frequency distribution and further types of area near to domestic housing and villages. VDI 3474 is conceived as an „open" guideline, expandable at any time to accommodate other types of animals, production systems and further know-

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Keywords

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Literature

[1] *Krause, K.-H.*: Behandlung von Transport und Ausbreitung gasförmiger luftfremder Stoffe in der Umgebung von Tierhaltungen. Landtechnik 38 (1988), H. 1, S.1-9,
[2] *Müller, H.-J., E. Grimm und K-H. Krause*: Geruchsemissionen und -immissionen aus der Rinderhaltung – Beurteilungsgrundlagen und Ableitung von Emissionsminderungsmaßnahmen. Abschlussbericht des Forschungsauftrages (96 HS 015) des BMVEL, 2000
[3] *Koch, R.*: Persönliche Mitteilung, Ersatzverfahren zum Emissionsschwerpunktverfahren und Hüllkurvenverfahren. Fürstenfeldbruck, Mai 2001

The regulations on distances between buildings as in the VDI guidelines „Emission reducing livestock production" up until now VDI 3471 (pigs) and VDI 3472 (hens) have proved themselves over 25 years in legally reliable judgements on odour emissions and emission results in the countryside and are the basis for the between-building distance TA air regulations. In over 80% of the judged cases covering building and legal emission protection permission processes, and in building area planning, their general application has proved sufficient. They thus play a substantial role in the simplification of the administration process. It is therefore in the direct interest of agriculture to take account of all relevant livestock types, new developments and knowledge regarding the future VDI 3474 guideline.

Development of the VDI guideline for livestock farming

The first draft of the VDI guideline appeared in 1974 as „Guideline on expulsion limitations". On this basis many emission investigations and inspections on around 600 farms were conducted from 1975 to 1977. The identification threshold distances determined in the lee of affected facilities were adopted with an almost doubled margin of safety in the distance regulations of VDI 3471/3472 in 1977. The minimum distance r_{min} between livestock production and domestic buildings was:

$$r_{Min} = a(P)\, M_T^{b(P)} \quad (1)$$

M_T represents livestock mass in LAU (large animal units) (= 500 kg), a (P) and b (P) polynomial 2nd grade in P [1]. For P = 0 (worst livestock housing facilities) the exponent b = 0.307, for P = 100 (best facilities) applies b = 0.338.

Despite the matching of the guidelines in 1986 to the technology standards being used, the unification of Germany and the associated infrastructure changes required methods for evaluating larger-scale cattle farms. Thus, VDI 3473 (cattle) was created as third livestock farming guideline, published as a draft in 1994. For meeting the requirements of the 1986 guidelines alone, the real emissions and emission results from, among other systems, open livestock production systems, only proved conditionally suitable. Mixed livestock enterprises were also affec-

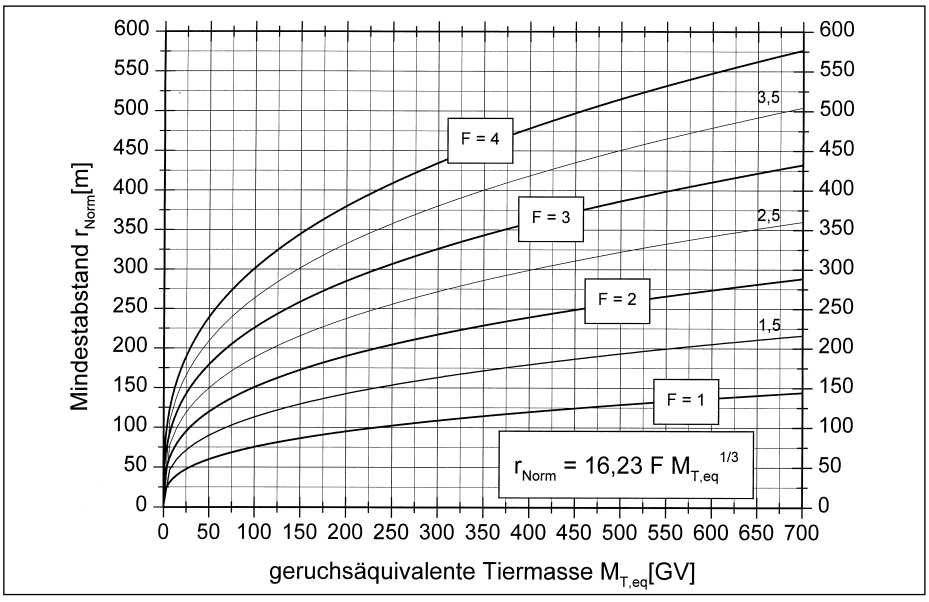

Fig. 1: Minimum distance r_{Norm} as a function of the odour-relevant livestock mass $M_{T,eq}$ for different F values

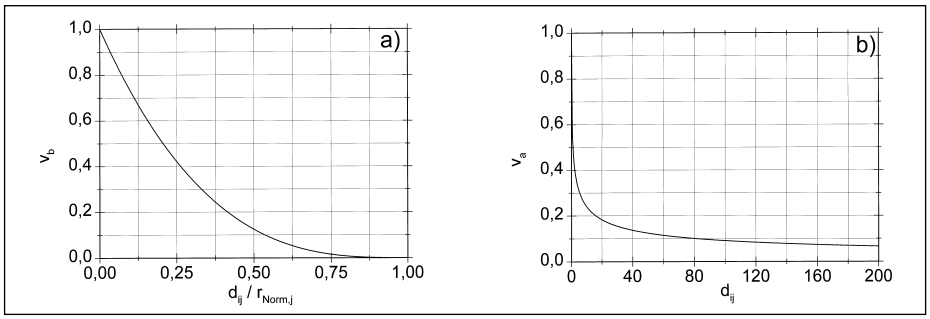

Fig. 2a: Transposition function v_b in dependence of $d_{ij} / r_{Norm,j}$. v_b reaches the zero-value at the norm radius

Fig. 2b: Empirical transposition function v_a in dependence of d_{ij}; v_a tends to zero for infinitely great arguments

ted. The revising of VDI 3473 (draft) was dropped in favour of the new VDI 3474.

General aspects of the VDI 3474 draft

The VDI 3474 draft is based on the VDI 3471 guideline regarding distances between livestock and domestic housing. The standard distance to be observed according to the new guideline is determined thus

$$r_{Norm} = K\ F\ M_{T,eq}^{1/3} \quad (2)$$

with

$$F = F_2\ (F_1 + F_3 + F_4) \quad (3)$$

$$M_{T,eq} = f\ M_T \quad (4)$$

$$f = f_{eq}\ f_{tech}\ f_{hed} \quad (5)$$

$$M_T = Z\ m_{T,einzel} \quad (6)$$

$$K = 16{,}23 \quad (7)$$

For F = 3 with $F_i = 1$, i = 1.4, r_{min} corresponds to nearly r_{norm}. Through coefficient comparison with A (P = 100) = 48.69 and F = 3 there follows the value for K as given in equation (7). The expression F characterised factors *independent of livestock production*, the term $M_{T,eq}$ *livestock production dependent factors*.

Airstreams flowing around and through livestock facilities are characterised by the form of building and the openings; in forced ventilation through positioning of exhaust air shafts and the way emissions are distributed. These channelling conditions are subtotalled under the factor F_1. Thus, e.g., exhaust air through shafts arranged in rows one behind the other makes itself uncomfortably recognisable in its surroundings where the air stream is longitudinal compared with the further transporting of odour material through a specifically planned vertical airstream. Factor F_4 depends on the orography. Factor F_3 on the meteorology in which the wind occurrence frequency is evaluated. Multiplying the sum of these factors with the area factor F_2 (= 0.5 for village area, 1 for general domestic housing area) according to equation (3) underlines the emphasis of the area character in distance measurements.

For the livestock production specific factors [equation (4) to eq. (6)] the number Z of animals is, next to the individual animal mass $m_{T,einzel}$ in LAU, is easiest to determine. The determining of the odour equivalent factor f_{eq} proved to be very complicated and in principle is possible only over research projects [2]. Values are available for pigs, cattle, poultry and horses for the storage of farmyard manure, slurry, poultry droppings and silage as well as for cattle loose housing.

The new livestock housing guideline starts from a state of technology with $f_{tech} = 1$. f_{tech} can be established through livestock housing emission comparisons. Corresponding values apply for the covering of emitting surfaces. The hedonistic factor f_{hed} is currently only used for cattle production with f_{hed} = 0.5, otherwise convention.

Conversion from one to several emission sources

The leading formula apparatus allows itself in principle to be transferred onto the interaction of several sources in that every emitting emission contribution is attributed to the surrounding emitting sources. The odour equivalent livestock mass $M_{T,eq}$ becomes in the process the extended $M_{T,erw}$. This contribution is according to how far the emitters are distanced from one another. If the direct distance d_{12} between two emission sources with $M_{T,eq.1}$ and $M_{T,eq.2}$ is so large that the associated standard distances $r_{norm.1}$ and $r_{norm.2}$ are not achieved in their total, then no increase in emissions occurs (increasing of the effective livestock mass) by one of the emitters. On the other hand, if the distance is so small that, because of overlapping, the standard distance circle d_{12} is smaller than the sum of the standard distances, then the emitters deliver mutually in each case an emission contribution roughly equivalent to the remaining difference between standard distance and distance d_{12}. Generalised to i = j sources, the overlapping process [3] delivers with the summation over i and j

$$M_{T,erw,i} = M_{T,eq,i} + \sum [M_{T,eq,j}\ v_b],\ i \neq j \quad (8)$$

with

$$v_b = (1 - d_{ij} / r_{Norm,j})^3 \quad (9)$$

The guideline VDI 3474 delivered the enlargement function v_a with

$$v_a = [1/(1 + \sqrt{d_{ij}})] \quad (10)$$

whereby d_{ij} is based on the running length „1“. In *figure 2a and 2b* the curve progress of v_a and v_b is presented in association from d_{ij} and $d_{ij}/r_{Norm,j}$. The function v_b is completed when the standard distance is zero whereas v_a first disappears for the infinitely large distance d_{ij}. The function v_a is empirically applied, v_b declares itself directly from the distance formulation of the guideline so that v_b should be given the advantage over v_a.

Determining the distance

Through the linking of several emission sources the distance determination between livestock and domestic housing starting of from a so-called emission focal point, can be limited to just a few exceptional cases. Applied as criterion is that the emission sources may not be more than 50 m distance from one another.

The so-called multi-source process is universally applicable and joins with the emission focal point process. A differentiated distance determination with reference to site factors is only possible with individual emission sites. On the other hand if one directly applies the F factors in a general sense for all distribution directions, distance curves can be construed which, with multi-source processes, can be comprised from the outer circle curves. The fault with the generalised observation is solved by isoplethic procedures, the third data evaluation method. Presented are the curves between the field points for which the required standard distance equals the actual distance.

Summary

The new guideline VDI 3474 is suitable for determining the emission-damage protection distance from natural ventilation, as well as forced ventilation, buildings to domestic housing under complex surrounding conditions. Here, methods are shown which move away from very rough determination of distance estimations to very detailed statements e.g. away from the simple circle form to the distance curves as they are known from distribution pattern simulations.