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Evaluation of Ammonia Immissions Under the New Technical Regulations Concerning Air Pollution

According to the new Technical Regulations Concerning Air Pollution (TA Luft), animal housing facilities must keep a certain minimum distance from sensitive vegetation and ecosystems. Otherwise, protection against ammonia immissions must be proven in a special case examination. Even though the minimum distance regulation is often not practicable because it is too much geared towards the worst case, TA Luft provides sufficient leeway for appropriate assessment: in the individual case, the distance requirement can be reduced by considering emission-reducing measures, and/or it can be sensibly supplemented with state-specific distance regulations.

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Keywords

Ammonia, environmental impact, set-back distance regulation, emission reduction

Literature

Literature references can be called up under LT 03203 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

On 1 October 2002, the revised version of the „Technical Regulations Concerning Air Pollution“ (TA Luft) [1] went into effect. For animal housing facilities, the revised regulations of TA Luft regarding ammonia immissions and nitrogen deposits are particularly important.

Fundamental Mode of Proceeding During Evaluation

According to the regulations of TA Luft, a special case examination of ammonia immission and nitrogen deposition is necessary if there are indications for harmful effects on sensitive vegetation and ecosystems. In order to determine if this is the case, TA Luft contains a distance regulation (appendix 1). The minimum distance $X_{TA\ Luft}$ (m), which provides an indication for harmful effects if not kept, is calculated based on ammonia emission Q (Mg/a) according to the following function (*fig. 1*, a; TA Luft):

$$X_{TA\ Luft} = (F_{TA\ Luft}\ Q)^{1/2}$$

with $F_{TA\ Luft} = 41.668\ m^2\ a/Mg$

If the distance (e.g. from the forest) cannot be kept, it must be proven with the aid of a simplified diffusion calculation that ammonia concentration does not exceed the value of 3 $\mu g/m^3$ as additional contamination or 10 $\mu g/m^3$ as total contamination. Only when this cannot be proven must a more comprehensive special case examination be carried out [4].

With regard to nitrogen deposition, the contamination structure is a criterion for harmful environmental impacts. If livestock density in a circular area exceeds the value of 2 LU/ha, this is an indication for harmful impacts, and a special case examination is necessary [4].

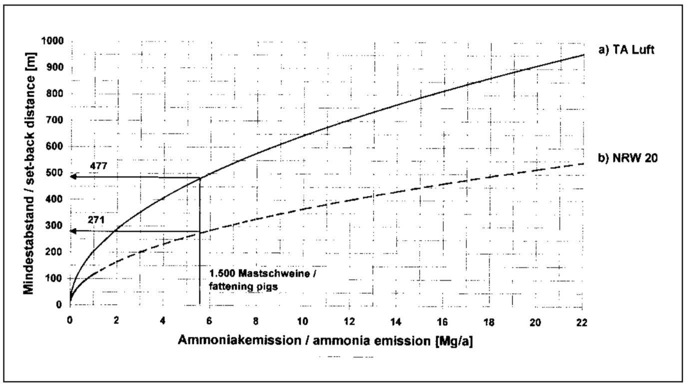

Fig. 1: Minimum distance to sensitive vegetation and ecosystems – a) TA Luft (appendix 1, fig. 4), b) NRW 2002 (recommendations for assessing ammonia emissions in the framework of permission procedures for animal husbandry facilities in North-Rhine-Westphalia [4])

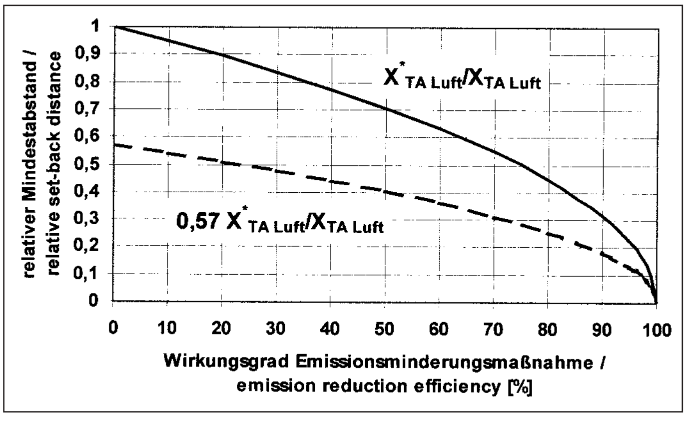

Fig. 2: Effect of efficiency of an emission reduction measure on ammonia minimum distance

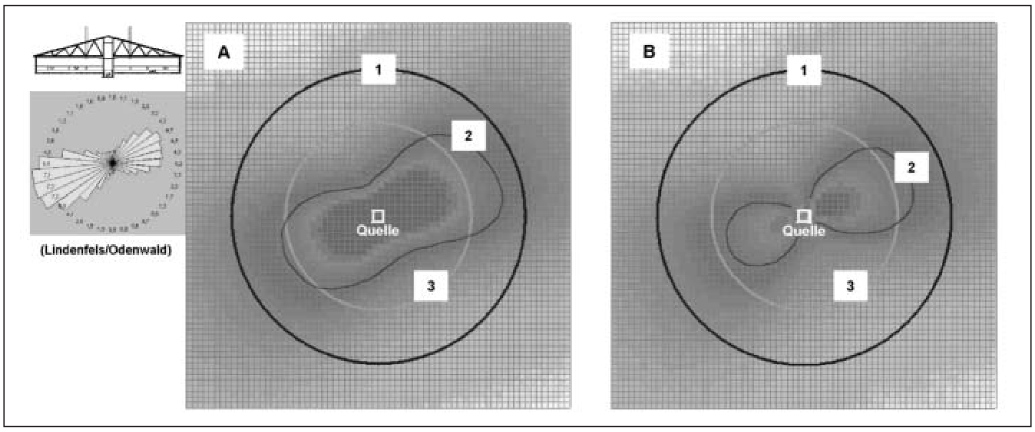

Fig. 3: Results of ammonia emission prognosis for a house with 1000 pig fattening places with different waste air ducting with considering the downwash effect; A) ventilation per compartment 1.5 m above ridge, B) central extraction 1.5 m above ridge; 1 ammonia minimum of TA Luft ($X_{TA\ Luft}$), 2 isopleth of ammonia 3 $\mu g/m^3$; 3 odour minimum distance of TA Luft

Emission Factors

The emission factors of TA Luft were taken over from the results of the R&D project of the UBA (Federal Environmental Office) [3]. These factors are conventional values determined for national emission reporting. Since they had not been developed for the evaluation of individual farms, they are insufficiently differentiated with regard to different housing techniques. TA Luft, for example, contains only one emission factor for the different areas of piglet production. In addition, the emission-reducing effect of N-adapted, multiple-phase feeding has not been considered in these factors even though, in principle, it must be taken into account according to number 5.4.7.1 c) TA Luft.

However, it is possible to determine emission factors which deviate from the requirements of TA Luft in individual cases if facilities significantly diverge from the considered techniques with regard to stalling up or feeding, for example.

The emission reduction degree η of a measure influences the minimum distance through a square root relation:

$$X^*_{TA\ Luft} = [F_{TA\ Luft}\ Q\ (1-\eta)]^{1/2} = X_{TA\ Luft}\ (1-\eta)^{1/2}$$

This means that a reduction measure must have an efficiency of at least 75% in order to halve the required distance. For a reduction to one quarter of the distance, a measure must have an efficiency of more than 93% (*fig. 2*). Even continuous exhaust air cleaning cannot guarantee such high efficiency.

In *table 1*, the mathematical influence of the most important emission-reducing measures on ammonia emission and the minimum distance from sensitive vegetation and ecosystems according to appendix 1 of TA Luft is shown using pig fattening as an example.

Distance Function

Depending upon ammonia emission, the distance function of TA Luft shows the limit distance at an irrelevant concentration of 3 $\mu g/m^{\geq}$ in the main wind direction. It was calculated using the program AUSTAL 2000 for the derivation of emissions close to the ground and unfavourable meteorological diffusion conditions. The value of 3 $\mu g/m^3$ has been determined such that even at unfavourable locations with heavy previous contamination no harmful environmental impacts must be expected.

For this reason, the regulation is very strict (cf. *fig. 1*). Since such locations are virtually impossible to find, a proposal made during the legislation procedure was aimed at easing the regulation for locations where higher additional contamination than 3 $\mu g/m^3$ is possible due to low previous contamination (e.g. in eastern Germany) or where the meteorological conditions are more favourable (in northern Germany). The first point at least was considered in the TA Luft.

With regard to the consideration of the second point, regulations are being developed at the state level. The state of North-Rhine Westphalia, for example, has developed a distance modification based on the meteorological data of Münster (*fig. 1, b)* North-Rhine Westphalia 2002). The distance function reads as follows:

$$X_{NRW} = (F_{NRW}\ Q)^{1/2}$$

$$\text{with } F_{NRW} = 13\,463\ m^2\ a/Mg$$

In North-Rhine Westphalia, minimum distances for the emission Q only amount to 57% as compared with the distance regulation of TA Luft, which applies at the federal level.

Due to the consideration of emission-reducing measures with the reduction degree η > 23% (*table 1*), distances are possible which are 50% smaller as compared with the initial regulation of TA Luft (*fig. 2*):

$$X^*_{NRW} / X_{TA\ Luft} = 0{,}57\ (1-\eta)^{1/2}$$

Since the distance functions have been derived for the unfavourable case of the main wind direction, the North-Rhine Wesphalian distance modification also considerably overestimates the minimum distance required for the protection of the environment in the secondary wind direction. This can be clearly shown through standard case calculations. This also allows the influence of exhaust air conduction and stall orientation on the immission situation and the resulting planning leeway for critical locations to be illustrated (*fig. 3*).

Table 1: Effect of emission reduction measures on minimum distance to sensitive vegetation and ecosystems acc. to appendix 1 of TA Luft, using the example of pig fattening

Housing system	Emission factor NH_3 [kg/(animal place•a)]	Emission reduction degree η in relation to the reference proced. [%][3]	Distance relation after consideration of the emission reduction measure $X^*_{TA\ Luft}/X_{TA\ Luft} = (1-\eta)^{1/2}$ [%]	Distance $X_{TA\ Luft}$ for 1500 fattening pig places [m]
Forced ventilation, liquid manure (small group)				
– one phase feeding (*reference method*)	3,64[2]	–	–	477
– N-adapted feeding[1]	2,8	23	88	420
Outdoor climate (cubicle) stall				
– one phase feeding	2,43[2]	33	82	391
– N-adapted feeding[1]	1,9	47	73	348
Forced ventilation, liquid manure (large group)				
– one phase feeding	3,3	10	95	453
– N-adapted feeding[1]	2,5	31	83	396

1) RAM feed standard [3]; 2) value of TA Luft [1]; 3) from [3]