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APPROACH TO ODOR NUISANCE EVALUATION IN SWITZERLAND

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ABSTRACT

Since the promulgation of the Swiss Environmental Protection Act, the annoyance approach has been established for odor regulation. The direct scaling of the extent of annoyance in the neighborhood of odor emitting plants has led to an evaluation scheme for public odor annoyance.

The problem-solving procedure starts with checking compliance with emission standards for specific substances. Olfactometry plays an important role in defining the state of the art for odor abatement systems. An evaluation scheme for odor emissions is applied.

The link between emission and public annoyance gives the assessment of odor frequencies as a measure of the ambient odor burden.

Key Words: olfactometry, odor annoyance, odor frequencies, public nuisance, frequency/annoyance relationship

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1. INTRODUCTION

In the Ordinance of Air pollution control (OAPC) of 1986 [1], annoying odors are regarded as excessive emissions. The following definition is to be found in Article 2, Section 5b:

"Emissions are deemed to be excessive if a survey determines that they significantly disturb the wellbeing of a major part of the population".

The Ordinance is based on the perceived extent of annoyance. In other words, a plant may emit such quantities as will not result in annoyance. This is why the Ordinance does not state any specific limit values for odors. Nonetheless, methods and assessment standards are needed to implement the Ordinance.

Before the possible extent of odor emissions can be clarified in a so-called "odor situation", the first step is to check whether the precautionary emission limits stipulated in the OAPC have been met. The decisive factor concerns especially those emission limits which help to avoid or reduce odor emissions. In this context, one

important precautionary measure is to identify and remove the emissions as described in Article 6 of the OAPC (e.g. the flue height).

A whole series of odor problems can be resolved by ensuring compliance with the existing precautionary emission limits. However, there are a number of emission sources which are not covered by these limits on account of their low concentrations, yet still result in odor pollution of the local environment. In such cases olfactometry can be used. With the aid of the human nose, odor samples are diluted right down to their detection thresholds. The dilution ratio or odor substance concentration is a measure of the strength of the source. Guideline values are available to allow the effects on the environment to be assessed. At the planning stage, requirements or guarantees can be defined regarding the limitation of the odor substance concentration. These guideline values enable the operator to check remediation efforts immediately, thereby documenting the state of the art.

The Swiss approach to evaluating excessive odors is based on the extent of the annoyance in the residential areas exposed to the odor pollution. Local residents must be consulted for the purposes of the evaluation. The extent or excessiveness of the odor burden can be determined by conducting a survey of the local residents affected. However, this approach is bound by certain conditions, e.g. a sufficient number of inhabitants living in the vicinity of the plant; what is more, this method cannot be applied at the planning stage.

At the present time, the best way to describe the emission burden involves documenting the frequency of specific plant odors. Based on random samples, the perception by test subjects of odors in the vicinity of plants is determined. Calibration takes place by questioning those concerned. In the event of any conflict, it is advisable to apply both methods – exposure of test subjects to the odors and questioning of the test subjects – to increase the reliability of the statements.

The emission burden caused by odors can be determined by means of the odor frequency. This method is also suitable in the case of very localized problems where questioning of local residents is not possible. Forecasts can be made even in the planning phase by using the distribution calculation. This method offers certain advantages from an administrative point of view, though it should be noted that frequencies cannot provide a complete description of the pollution situation.

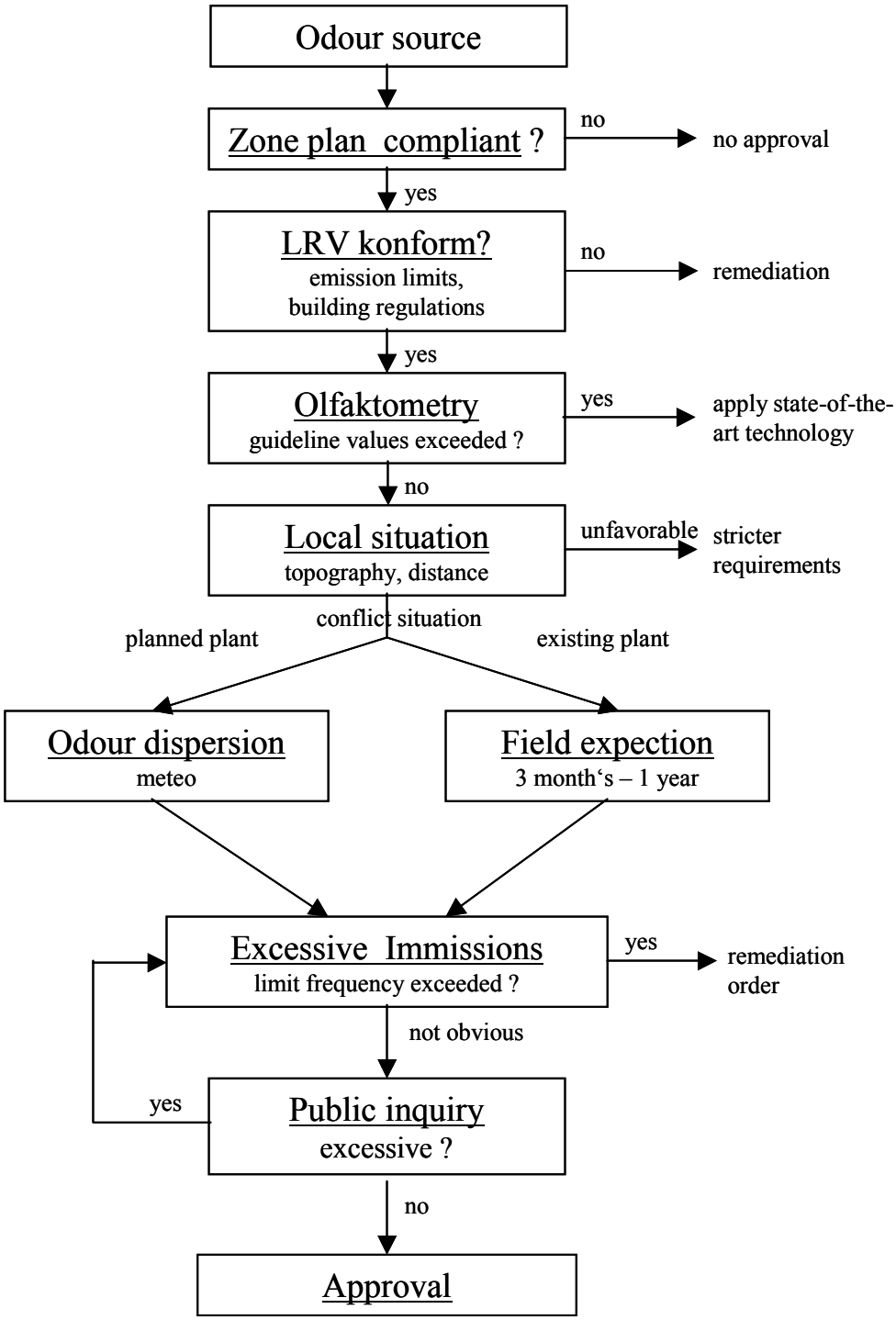

Figure 1: Flow chart showing procedure for dealing with an odor pollution complaint.

2. OLFACTOMETRY

Odors are generally made up of a large number of chemical substances which can affect the olfactory organ in different ways, depending on the type of substances and the concentrations in which they are present. On account of the number of different components, which is almost always very large, it is not possible to conduct a chemical analysis of the individual odor substances. What is more, even if all the contents of a particular sample are quantitatively determined, the odor that the sample causes cannot be described.

Olfactometry is a suitable method of conducting an "engineer's" evaluation of measures taken to reduce odor pollution, as it allows a measure and the odor reduction to be expressed in terms of mass and figures.

The olfactometry process uses the human nose as a detector. Compliance with certain principles which are laid down in standards [2,3] is important. Both the participating "smellers" and the dilution apparatus are subject to specific requirements. Although the scatter of the measured values is fairly large, the measurement process is also a biological one. Reliable statements can be made, especially when it comes to making a relative assessment of a particular measure.

A variety of measurements for different odor sources has resulted in a pragmatic system for evaluating odor emissions [4].

Class	Range	Likely effects
I	< 100	High probability of no odor emissions
II	100 - 300	High probability of no odor emissions if: • the waste air is routed through a flue • residential areas are more than 300 m away • the potential burden is low
III	300 - 1000	Odor emissions are possible but can be avoided by: • using a high/higher flue • ensuring that residential areas are more than 600 m away
IV	1000 - 3000	Odor emissions are probable: • a very high flue is necessary • action must be taken within the plant
V	over 10,000	purification of waste air is necessary

Table 1: Guideline values for odor emissions in odour concentrations [OU/m^3]

Depending on its topographical situation, a plant can be assigned to one of the above classes. If the values measured in a plant are below a stated range, emissions can be ruled out; above this range there is a high probability of annoying emissions. This

applies to a mean range of volume flow rates from 5,000 to 50,000 OU/m^3. The type of buildings in the local area is taken into account for the purposes of this classification. It often happens that industrial and commercial plants were built a long time ago in the open countryside, with residential housing coming closer and closer to the factory boundaries. The Swiss Air Purity Ordinance stipulates that this must not result in significant odor pollution. It is not necessary to apply the same standards to plants in undeveloped areas as are applied to those right in the middle of residential areas, allowing some flexibility in the application of the guideline values.

3. ODOR ANNOYANCE

Subjective odor annoyance is no simple indicator of effect, and is largely impossible to define medically. A number of different factors determine the extent of the annoyance, such as the degree of perception, pleasant or unpleasant impression, attitude to source and, above all, a person's feeling of being at the mercy of the odor. Nonetheless, a person is able to make an integrative evaluation and to express their feeling of annoyance using a simple scale:

Odor annoyance is determined by surveying the local residents affected [5]. The zone chosen for the survey should be exposed to as homogeneous an odor pollution as possible, and must contain at least 40 residential units. If these conditions are met, the average self-evaluation score on the annoyance thermometer can be regarded as a measure of overall annoyance. The percentage of "extremely annoyed" people, i.e. those who classify their level of annoyance on the scale as being above ≥ 8, is likewise determined

It was found in a number of studies conducted in the vicinity of odor-emitting industrial plants that the 10 percent proportion of extremely annoyed people is reached at an average value of 3 and the 25 percent proportion is reached at an average value of 5 [6].

The evaluation takes place on the basis of the Swiss Noise Abatement Ordinance. The Noise Abatement Ordinance specifies an emission limit value of 60 dB(A) and an alarm limit value of 70 dB(A) for residential zones during the daytime. If these noise limit values are viewed in the context of the number of extremely annoyed persons, approximately 10 percent of those affected feel extremely annoyed when the emission limit value is reached, and approximately 35 percent when the alarm limit value is reached.

The following figure plots the level of tolerance to noise and odor emissions from the point of view of those affected against their perceived level of annoyance. The noise curve shows a shift towards "greater tolerance", which means that odors are accepted to a lesser extent than noise emissions at the same perceived level of annoyance.

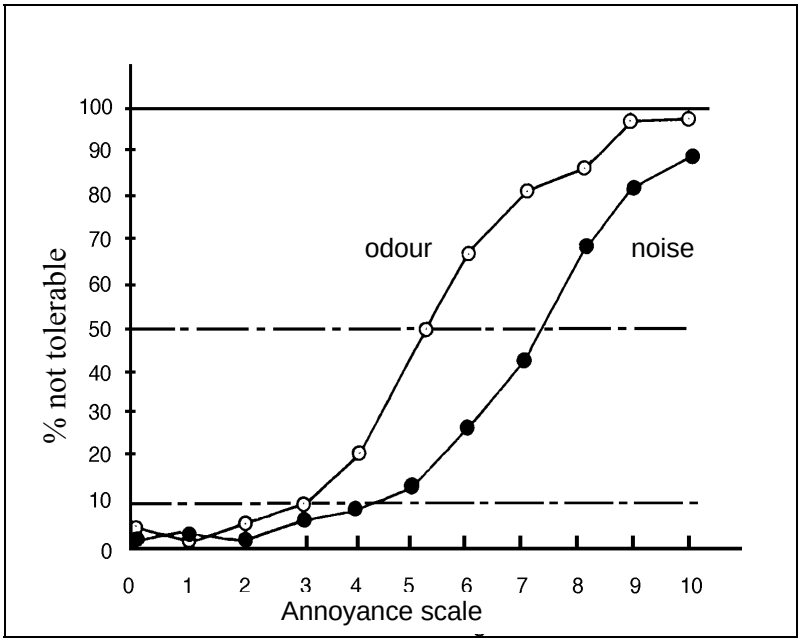

Figure 2 : Tolerance from the point of view of those affected, against perceived level of annoyance

Taking the reduced level of acceptance of odor emissions into account, the following evaluation system can be applied:

Odor level	**Degree of annoyance**	**Percentage of highly annoyed persons**	**Measures**
High	> 5	> 25 %	Immediate measures
Medium	3 - 5	10 - 25 %	Long-term measures
Tolerable	< 3	< 10 %	No particular measures

This type of survey has its limitations, however, especially during the planning of a plant or when the residential houses first have to be designed. In this case one is reliant on estimates which are based on model and distribution calculations and whose outcome is to show the frequency of odor threshold violations in a particular area.

4. FREQUENCY OF ODORS

This method of determination takes direct advantage of the effect of odorous substances on the human sense of smell. The measured variable is the odor time proportion, i.e. how often the detection threshold in the outdoor air is violated.
To determine the emission burden, therefore, the human nose is used once again: neutral test subjects, chosen according to a previously defined random sample concept, enter a polluted area, where their odor perceptions are recorded at various control points [7].

Frequency/annoyance relationships were determined in a series of studies [8]. The frequencies relate exclusively to odors from industrial plants.
Food, grass drying and paint factories were classified in the questionnaires as "less unpleasant", while the remaining plants – chemicals, asphalt production, creosote, rubber latex, gelatin production and animal feed – were classified as "very unpleasant".

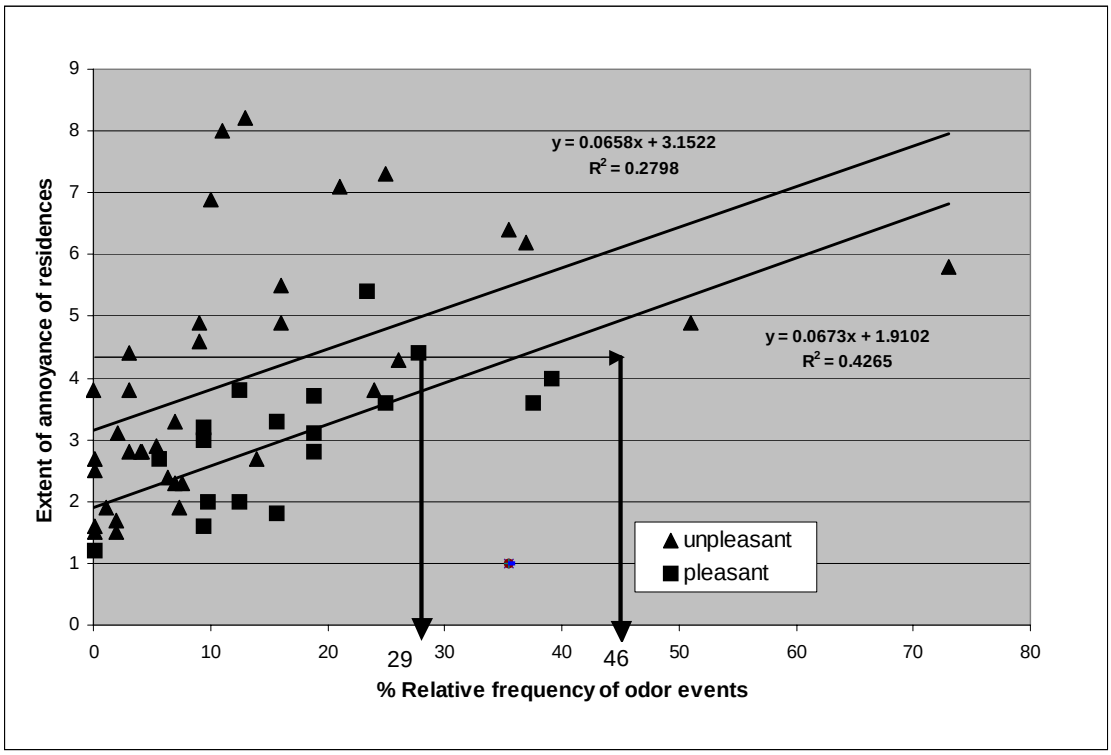

Figure 2: Frequency – annoyance relationship with respect to hedonic tne

It can be seen from Figure 2 that no simple linear relationship exists. The smoothing function shows roughly a shift by 1 scale unit on the annoyance scale if the hedonic tone is taken into account.

5. CONCLUSION

The extent of annoyance can only be determined by means of socio-psychological methods if the affected population is taken into account. At the same time, locally aesthetic values must be considered.

From an administrative point of view, the criterion of odor frequencies is easier to handle than the survey method. This method can also be used in the planning phase and in the case of smaller affected residential areas.

They are only suitable for describing the degree of annoyance to a limited extent. The same frequencies can produce different annoyance reactions, and here it is the hedonic impression on the "pleasant – unpleasant" dimension which plays a decisive role.

In important cases it may prove beneficial to apply the survey and exposure methods at the same time. This allows the odor frequencies to be calculated on the basis of current reactions of the population. In this case, odor frequencies will be individually defined for each particular plant.

REFERENCES

Ordinance of Air pollution control of 16. December 16, 1985 (as at July 1, 1993). SR 814.318.142.1.
DIN EN 13725: Air Quality – Determination of odour concentration by dynamic olfactometry. 2003
VDI 3881 Part 1: Olfactometry – Odour threshold determination - Fundamentals. Berlin Beuth-Verlag Berlin 1986.
Fundamentals of odour evaluation. Swiss Agency for the Environment, Forest and Landscape, Report No. 115, 1989
VDI 3883 Part 1: Effect and Assessment of Odours – Pychometric Assessment of Odour Annoyance - Questionnaires Berlin Beuth-Verlag Berlin 1997.
Hangartner, M.: Bewertung von Geruchsbelästigungen.
Staub – Reinhaltung der Luft 48 (1988).
VDI 3940: Determination of Odorants in Ambient Air by Field Inspections Berlin Draft Version Nov. 2003.
Hangartner, M: Geruchshäufigkeiten als Mass der Geruchsbelästigung.
Staub – Reinhaltung der Luft 54 (1994) Nr. 2, S 45-49