Protection against aircraft noise. Novella of the German law of October 31, 2007

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PRESENT STATE

The „law of protection against aircraft noise" of 3/30/1971 in Germany contained limit values of 75, 67 and 62 dBA as protective zones, calculated to $L_{eq4,0\text{-}24h}$. These limit values served primarily for the settlement of zone planning and were not founded healthwise. The amendment of this law of 10/31/2007 occurred under inclusion of health points of view. The maximum values of this new law version were determined according to $L_{eq3,6\text{-}22h}$ for the day strain and $L_{eq3,22\text{-}6h}$ for the night strain. In addition to the judgment with the help of the night equivalent continuous sound pressure level the maximum level recorders L_{max} has been considered as another important criterion.

Table 1: Emission Values Law of 10/31/2007

	Existing Airports	**New Airports**
Day – Protection Area 1	65 dBA	60 dBA
Day – Protection Area 2	60 dBA	55 dBA
Night - Protection Area	55 dBA 6 x 57 dBA	53 dBA 6 x 57 dBA
Starting 2011		**50 dBA** **6 x 53 dBA**

Beside the law of 1971 existed the air traffic-licensing order (LuftVZO) which apart from the attention of the law demanded a physical - technical certificate about the aircraft noise strain and also medical certificate about the possible health effects by independent consultants. These consultants according to the LuftVZO were obliged therefore legally to provide an objective scientific certificate about the state of the noise effect research which led of course over and over again to personalized discussions.

Therefore the scientists Prof. Dr. Griefahn (Dortmund), Prof. Dr. Jansen (Düsseldorf), Prof. Dr. Scheuch (Dresden) and Prof. Dr. Spreng (Erlangen), who represented different main focuses of the noise impact research (NIR), compiled in 2002 a comprising representation of the essential results of the NIR, the so called "Synopsis" (Griefahn et al. 2002) which were confirmed in the essentials after an examination in 2007 (Scheuch et al. 2007). The "Synopsis" was described on occasion of the ICBEN Congress at Rotterdam (Jansen et al. 2003).

The different protective aims health, nuisance, sleep disorders, communication disorders and recreational disorders were considered individually. The corresponding noise emission limits were implemented in gradated effect descriptions as „critical tolerance values (KTW)", „preventive approximate values (PRW)" and "quantitative threshold values (SW)" and recommended. As a judgment measure the continuous sound pressure level L_{eq3} and the maximum level recorder L_{max} were pulled up. In the

novella of the law of 10/31/2007 became, as already mentioned, also L_{eq3} and L_{max} as judgment criteria applicable.

In Table 2 the suggested values are performed with different protective sighting and the day protection zones of the FlugLärmG, Table 2b contains those for the night. Moreover, judgment values of protective-destitute areas were derived. An essential advantage of the Synopsis is that medical, i.e. physiological, pathophysiological and clinical aspects as well as epidemiological, psychological and socially scientific findings were considered. Also different questions of noise physics were included under noise impact research points of view. Therefore it is an adequate complicated and comprehensive bio-psychosocial approach with objective judgment of the contribution of the single specialty disciplines around to the object of the noise effects. Another important advantage of this Synopsis and its grounds compared with many publications in this field is that results of other strain research fields, not only the noise, have been included. This concerns in particular the results of the stress research, the working strain research, knowledge of the psychosomatic medicine and results of the risk research in other areas. This concerns in particular the results of the stress research, the working strain research, knowledge of the psychosomatic medicine and results of the risk research in other areas. This concerns in particular the results of the stress research, the working strain research, knowledge of the psychosomatic medicine and results of the risk research in other areas. The difficulties of an isolated noise effect research and noise effect consideration, the lacking classification of noise-related study results in the medical and psychological research all together lead to misinterpretations and lacking acceptance.

Table 2a: Limitation values of the Synopsis and the aircraft noise law for the protection (in italics) as well as classification of everyday sound charges on the day (equivalent continuous sound pressure level) 1 = Synopsis, KTW: Critical tolerance value, PRW: Preventive appoximate value, SW: Threshold value, 2 = Aircraft noise law for the protection. A: Kerschsieper et al. (2006), B: Fischer (2007)

Level dBA	**1 Synopsis** ***2 Fluglärmschutzgesetz***	**Classification**
70	1 KTW Health	Work Social-Occupation [B] 69-76 dBA Shopping Mall [A] 71-72 dBA normal street traffic Conversation raised silent hairdryer (1 m of distance)
65	1 PRW Health KTW Considerable Nuisance ***2 Day protection area 1 continued existence***	Commuter Train [A] 66-75 dBA Radio/TV raised Hotel at the Sea
64	1 KTW Recreation	Dishwasher 63-71 dBA
62	**1 SW Health** **1 PRW** Considerable Nuisance **KTW Communication**	**Office [A] 62-64 dBA** **Spare time social-occupations [B] 59-64 dBA**
60	*2* ***Day protection area 1 continued existence*** ***Day protection area 1*** *New*	normal conversation
59	1 PRW Communication	
57	1 PRW Recreation	
56	1 SW Communication	
55	1 SW Considerable Nuisance ***2 Day protection area 1*** *New*	**Radio/TV household noise level** Vacuum cleaner (10 m of distance)
50	1 SW Recreation	light rain quiet brook smooth conversation

Assigned were everyday events with her sound level recorders which were measured in average in each case for the duration of these events. They permit a better appraisal of the sound limitation values.

Table 2b: Limitation values of the Synopsis and the aircraft noise law for the protection (in italics) as well as classification of everyday sound strains at night (inside), see also explanation Table 1

Level dBA	**1 Synopsis** **2 *Fluglärmschutzgesetz***	**Classification**
50		Bird's twitter (15 m of distance)
40	1 KTW *2* ***Night protection area 1 continued existence***	quiet radio music Fridge
38	*2* ***Night protection area 1*** *New until 2010*	
35	1 PRW ***Night protection area 1*** *New starting 2011*	very quiet room ventilating fan
30	1 SW	Whisper

FINDINGS AND DISCUSSIONS IN THE NOISE EFFECT RESEARCH AND POLITICS FOR LIMITATION VALUES OF AIRCRAFT NOISE WITH THE MAIN FOCUS HEART AND CIRCULATION ILLNESSES

After the announcement of the law in 2007 there have been other examination results of the NIR which mostly confirm to a great extent the limitation values of the law in 2007, but also in the partly political discussion further reductions were demanded.

In the beginning of 2006 Babisch presented an analysis of a total of 61 works published since 1968 to the statistical association between the acoustic strain by aerial noise, train noise and traffic noise on the one hand and blood pressure / hypertension as well as ischaemic heart illnesses on the other hand. In 14 examinations the blood pressure was measured differently of very exposed adults. In 4 examinations with the stronger exposed group this was slightly, at least systolically, but significantly higher than in the group of less exposed ($p<0.05$). The other studies produced partly contradictory results. To sum up, Babisch states that there would be no epidemiological proof of an increase of the blood pressure by traffic noise. This also applies to the hypertonia under acoustic strain. 18 works focused on hypertension as a medical diagnosis with differently strongly exposed people. While this with people with higher strain by aircraft noise was not even significantly higher than with the less loaded people, there was no clear picture for the traffic. Babisch states (*'Across all studies no consistent pattern of the relationship between the community noise and prevalence of hypertension can be seen.'* p 29) and *('a higher IHD risk was relatively consistently found in the studies')* the significance level also increases if residential situation, room layout and window aperture duration behavior are considered.

Recently Babisch & van Kamp (2009) published a meta-analysis to the relations between aircraft noise and hypertension. It is stated that the knowledge is lower to effects from aircraft noise than to street noise, because big clinical studies would be absent. There is a distinction between studies with regression beginning and with category beginning (see above). Sufficient qualitative proof is supposed that aircraft

noise raises the hypertension risk with adults. This is concluded on the basis of the regression analysis. The given increase of the risk for the development of hypertension about 13 % per 10 dBA increase is based on the linear trend coefficient of 5 studies and is significant. With the categorical approach on the opposite no relevant relation were identified and from the authors – and this is generally an essential problem of different noise effect researches – was indicated on the differing noise data. It is seldom the actual measured equivalent noise level recorder, but in the single countries differently calculated noise descriptions with different "penalty kicks" for certain times of day or other conditions which serve as a base factor for the noise exposure. This also leads to the fact that in a regression beginning though these differences are reduced, but the statement, e.g. referring on 10 dBA, is only a calculated parameter. Thus it is also found out by the authors Babisch & van Kamp (2009) that is unclear whether the weighted noise indicators with surcharges reflect really adequately the physiological reactions. A whole series of concrete information would be necessary for a comparison and an evaluation of these noise parameters for example the frequency of the aircraft noise in certain times. It is stated by the authors Babisch & van Kamp (2009) that there is no simple, generalized or in certain times empirically supported dose-effect-relation for the coherency between aircraft noise and cardiovascular risk on account of methodical differences between the studies (noise appraisal, noise indicators, definition of the hypertension) and the absence by continuous or semi continuous noise data in the suitable publications. Therefore no clear result can be given to a possible effect threshold and that all descripted relations between aircraft noise and hypertonia are provisional due to the limitations of the corresponding studies. Further research studies are demanded to get a better evaluation of the risks.

To sum up, noise can lead like other unspecific stressors to a blood pressure raise and also hypertension. Nevertheless, a dose effect relation with a possible threshold is not academically provable in the area of traffic noise on the basis of the present study results.

Because there is a slightly raised risk under noise for heart circulation illnesses (in comparison to other risk factors), it is unfortunate that noise is not considered in the big national and international medical long time studies in the heart circulation area with the capture and observation by relevant risk factors.

NOISE AND SLEEP DISTURBANCE

In the foreground of the research of the last years stood epidemiological examinations which concentrated nearly exclusively upon the long-term sound level recorders at night, because maximum level recorders and their frequency with this basic approach were not available to studies. Therefore are still relevant on the basis of the awakening reactions and the Cortisol - model derived limitation values of the maximum level recorder frequencies. (Basner et al. 2006, Griefahn et al. 2002)

Hume (2008) summarized into his overview seminar paper the results of the last years concerning sleep disorders by noise and gave a view of the next five years.

He stressed that the essential development of the knowledge in this area during the last five years are the results of the DLR study. The question of the long-term sound level recorder and single level recorders was also discussed by Hume. The use of single level recorders was above all also explained with the fact that the long-term

sound level recorder had a too low verifiability for the affected persons. The dialogue and the revisability of defaults are an increasingly more important factor. This is also special difficulty of the use of the DLR results in general at airports and also for the airport of Leipzig/Halle. By Hume it was also stressed that in spite of all strains and work of the last years presently no statement are feasible to the long time effects of a disturbed sleep. He stressed the need from epidemiological as well as experimental research basic approaches. He also stated that hardly statements exist to the effects from sleep disorders of special vulnerable groups, in particular sick people, old people, or children.

In October 2009 were published "Night Noise Guidelines" by the WHO as an official document. This document is based on a research report of an expert's group. Already in 1999 the WHO published Guidelines for Community Noise, so the current recommendations are regarded complementary to this publication. Recommendations for the member states of 1999 are looked as still prevalid and relevant, although judgment values meanwhile have changed. The research report of a stated international expert's committee went through a WHO-internal and external investigation process (Babisch in 2009, 2010).

As from the WHO-regional manager for Europe Marc Danzon (WHO 2009) pointed out, these Guidelines are neither standards nor legally binding criteria. This guide is presented for the reduction of more negative health effects by night noise on the basis of expert's opinions and their scientific knowledge. The present level of knowledge is reported critically of the relations between night noise and health effects and still existing deficits of the knowledge are discussed. To these findings is a great consent given.

For the judgement of the night noise a night average level (L_{night}) is used. This also corresponds to the method usual in Germany to make a distinction between day and night level recorders. This L_{night} is valid for eight hours. Maximum level recorders and their frequencies are not included as limit values or aim values, but by the derivation of L_{night} they play a role (see below).

In the Community Noise Guidelines of 1999 appointment sound level recorders of 45 dBA were called outside flats and 30 dBA inside as target values to the avoidance of sleep disorders which should not be crossed. These target values are reduced with the current document to 40 dBA.

This is founded with new knowledge in particular by Passchier-Vermeer et al. (2002) and the DLR study (Basner et al. 2004) while the DLR study gets away all together with its very extensive results very briefly and that has identified just for the long-term sound level recorders at night no essential effect dependency. Therefore, particularly these studies, nevertheless, do not support the lead of this new directive limit value. Furthermore an interim target value of 55 dBA is given outside at night as a minimum aim if at short notice if 40 dBA are not to be reached.

It is pointed out the need of other examinations as well as some limitations, likewise the possibility of the Habituation and the unclear role of the day noise.

NOISE, NUISANCE AND HEALTH

While the danger can have a medical, pathophysiological, being off sick character in the essentials, the considerable nuisance or considerable interference is marked by the fact that by noises conditioned, unwanted strong influences of human behavior

patterns appear. This does not need exist objectively, the individual assessment, the individual experience identify substantially the occurrence of a considerable nuisance.

It is recognized that a zero nuisance as well as a zero portion of considerably bothered is not to be realized in the society. This is due to the fact, that

- there is a certain basic totality with negative information to all asked nuisance factors, a certain portion of people feels bothered by all they are asked,
- with questionnaire inquiries a trend towards the middle exists,
- dismay causes a different valency as a function of a variety of situative and personal factors of influence by which a total of a considerable width is to be registered by answer trends,
- the capture methods lead the subjective information mostly on a sound level recorder back, nevertheless, this is only one factor of influence on level recorder – nuisance - relations,
- the causing of negative feelings / interferences often is assigned to factors that resulted not of own responsibilities
- human life needs and generates certain sound level recorder areas and everybody is concerned by it.

On the other hand, a consideration with other risks and consequences has to occur by the assessment of nuisance which nevertheless is not an immediate job of a noise effect judgment.

With all discussions about the lead of sound level recorder – nuisance - relations is not to be forgotten that academically by the sound level recorder only a low part of the so-called variance of the relations is cleared up by sound level recorder and the information of nuisance. In the noise study in 2000 around the Zurich airport this is at most 15 % (Wirth 2004), meaning 85 % of the given nuisance by aircraft noise is not identified by the height of the sound level recorder. Generally the variance clarification of the relations nuisance sound level recorder is given between 9 and 33 % (among others Guski et al. 1999). This also means that different scientific efforts must be afflicted for the lead of level recorder-related limit values with considerable mistakes. However, assessment margins are settled nearly always with the sound level recorder. Nevertheless, there exist between sound level recorder and nuisance dose effect relations which are not distinct in other areas so clearly (Miedema & Vos 2003). However they are not - as this is often postulated - about all level areas linearly.

The results of scientific examinations to noise-conditioned nuisance and relevance vary between 50 and 70 dBA.

Despite the big variability of the examination results of numerous authors becomes evident that nuisances appear between 50 and 55 dBA and are probably considerable from 60-65 dBA, because between 28 % or 30 % of the exposed call themselves "extreme" or "strong" bothered.

FINDINGS AND PROBLEMS OF THE NOISE EFFECT RESEARCH OF THE LAST YEARS

Studies of the last years underline

- The night aircraft noise plays a special role and shows more close relations with heart illnesses and circulation illnesses (e.g., hypertension) as day noise, relevant is the maximum level recorder.
- The day aircraft noise raises the occurrence of coronary heart diseases; nevertheless up to L_{eq} = 70 dBA not significantly, but the relative trend already does begin with 60–65 dBA.
- Considerable nuisance: The level recorders sway to different studies around more than 10 dBA, newer examinations show higher percentages with lower level recorders, the common variance of level recorder and nuisance decreases during the last years clearly.

Still there is in the noise effect research a row of unsettled effect questions which are answerable only complex and interdisciplinary. A few examples are given:

- the effect from over all noise and the combination of different traffic noise sources,
- actual, academically sounded thresholds for disease genesis,
- the relations between considerable nuisances and diseases
- the effects of the noise on old people, sick people and concerning the health also children,
- the relations of the different noise measuring dimensions to the health.

The to be strengthened noise effect research has to dedicate more attention to the methodical problems in the planning as well as the interpretation. Population-related elevations are often supported by associations, interest representatives or lawyers. The result is the investigation of risk populations or from particularly health enthusiasts.

Among the rest this leads to the restrictions known in the social sciences of the quality of studies by "overreporting" up to the "Nimby effect" (Not in my backyard) or "Intra Class correlations" (families, association members, neighbors have often same answer trends). To this can be counted also other presented studies which were realized in the temporal connection with planned changes by airports. Conclusions for limitation values cannot be drawn from studies in such situations.

Also, the evaluation quality of many studies not seldom leaves much to be desired, because in the compulsion after the relevant results which should be quickly able of publication hardly concerning the contents sustentative selection procedures and arithmetic procedures are carried out. Here must be also classified the different noise quartile zones by Greiser & Greiser (2010) which enclose class sizes of 2 dBA to 13 dBA. With this false results are produced under effect aspects. This is also to be owed to the publication habits that above all "positive", "relevant" results must published, the so-called "publication-bias".

The mathematical-statistical treatment of data is means for the purpose of, condition for the interpretation of the results achieved are the assessment and the treatment of the input data and the assessment of the source data for the expected, academically to be founded effects. This can occur only according to scientific criteria hand in hand

with the present knowledge of the medical and psychophysiological exposure research. Noise effect research has the job to forecast effects and not to produce isolated calculations. Adequate to the data level, most authors value their results in the scientific publications quite critically.

This critical attitude is to be missed in hearings very often. It is legitimate that in hearings and other procedures only the respectively discussed exposure factor plays a role. Nevertheless, conclusions infuse themselves not without a proper risk comparison.

On the other hand sound and noise characterizes human life. Sound is necessary, also noise, appearing everywhere, in his effect unspecific, the effect spectrum and the effect type is like many other factors of human life. Therefore it is necessary also with the traffic noise, and here especially the aircraft noise, to classify and put in relation this in the usual sound strains of the specific person. Besides this physical bases are to be considered, for example perceptibility with level recorder differences, logarithmic dependence of the effect from the sound level recorder, measurability among other things.

Essential defects in these discussions to results in the noise effect research are:

- lacking or missing consideration of the quality of the input data and the insufficient inclusion of confounders/additional factors of influence within the interpretation,
- non-consideration of the totality of the results and their evaluation, only "suitable" results are shown,
- overemphasis of multivariate statistical procedures without consideration of the quality of the input data and a missing sound interpretation, psychologically or medically, of the results,
- missing classification of the results in biological and medical processes by which only the relevance of the results becomes evaluable,
- non-consideration of knowledge from other strain areas of the person,
- missing classification in the usual sound strains of the person with which the test of the ecological plausibility is avoided,
- non-consideration of criteria of the environmental law and bases of the risk assessment, for example not the effect from environmental factors in itself is relevant, but its adversity, protective criteria are not able to considerate any single persons concern.

The science does not decide on limitation values, but has however to make clear the instep width and security of the knowledge to (adverse) effects.

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