

ENVIRONMENTAL  
SERIES No. 329

Noise

Noise Abatement  
in Switzerland

Status and  
Perspectives



Swiss Agency for  
the Environment,  
Forests and  
Landscape  
(SAEFL)



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## Abbreviations

FEDRO	Federal Roads Office
FOAFL	Federal Office for Air Force Logistics
SFOPH	Swiss Federal Office of Public Health
FOT	Federal Office of Transport
FOCA	Federal Office for Civil Aviation
SFSO	Federal Statistical Office
SAEFL	Swiss Agency for the Environment, Forests and Landscape
dB(A)	Decibel A-weighted
DIN	German Institute for Standardization
EJPD	Federal Department of Justice and Police
EMPA	Federal Laboratories for Materials Testing and Research
ES	Sensitivity category
ETH	Swiss Federal Institute of Technology
EU	European Union
EEC	European Economic Community
GIS	Geographical information system
ICAO	International Civil Aviation Organisation
Leq	Equivalent continuous sound level
Lr	Rating sound level
NAO	Noise Abatement Ordinance
NNI	Noise and Number Index
SUVA	Swiss National Accident Insurance Organization
LPE	Federal Law relating to the Protection of the Environment
DETEC	Federal Department of Environment, Transport, Energy and Communications
DDPS	Federal Department of Defence, Civil Protection and Sports
VDI	Verein Deutscher Ingenieure
WHO	World Health Organization



## Abstracts

The report provides an overall view of noise abatement activities in Switzerland, reviews the current status, highlights the strengths and weaknesses of strategies, and points up possible opportunities for action. Although endeavours to reduce noise have already achieved a great deal, intensified efforts are necessary to ensure full protection of the public.

From an overall standpoint, the objectives of expansion and intensification of all aspects of noise abatement will receive priority, enabling the steady increase in noise in the living spaces of human beings and animals to be reversed. In addition, strategic extensions are required to enable noise to be more effectively combated – i.e. noise having detrimental effects on health, economic prosperity and social life.

Der Bericht vermittelt einen Überblick über die Lärmbekämpfung in der Schweiz und stellt neben dem Status quo auch die Stärken und Schwächen der Strategie sowie Perspektiven für den möglichen Handlungsraum vor. Obwohl die Lärmbekämpfung bereits viel erreicht hat, zeigt es sich, dass für einen umfassenden Schutz der Bevölkerung noch mehr Anstrengungen notwendig sind. Als Perspektive drängt sich einerseits in der Zielsetzung eine Ausdehnung und Verstärkung des Lärmschutzgedankens auf, damit der stetigen Verlärmung der Lebensräume für Mensch und Tier Einhalt geboten werden kann. Andererseits sind auch strategische Erweiterungen vorzunehmen, um den Lärm als Ursache für gesundheitliche, wirtschaftliche und soziale Auswirkungen wirkungsvoller zu bekämpfen.

Le présent rapport donne un aperçu de la lutte contre le bruit menée en Suisse. Non seulement il présente la situation actuelle, mais relève les points forts et les faiblesses de la stratégie et ouvre des perspectives sur des actions possibles à l'avenir. Bien que des résultats appréciables aient déjà été atteints, force est de constater qu'une protection intégrale de la population appelle une intensification des efforts. Il convient d'abord d'étendre et de renforcer la notion de protection contre le bruit afin de mettre un frein à la pollution phonique rampante qui envahit les milieux de vie des hommes et des animaux. Il faut en outre élargir la stratégie afin de lutter plus efficacement contre les nuisances sonores, responsables d'atteintes à la santé et de difficultés économiques et sociales.

Nell'offrire una visione d'insieme della lotta contro il rumore in Svizzera, il rapporto presenta, oltre allo stato attuale, anche i punti di forza e le debolezze della strategia in atto, nonché le prospettive per gli interventi possibili. Sebbene si sia già fatto molto nella lotta contro il rumore, sono richiesti sforzi aggiuntivi per offrire alla popolazione una protezione più completa. Da un lato si prospettano necessariamente come finalità l'ampliamento e il rafforzamento del concetto di protezione fonica, in modo da riuscire a contrastare il continuo aumento del rumore negli ambienti di vita, a beneficio sia delle persone che degli animali; dall'altro si deve intervenire anche con una strategia più estesa per combattere con maggiore efficacia il rumore in relazione i suoi effetti sulla salute e al suo impatto economico e sociale.



## Preface

The foundations of noise abatement in Switzerland were laid down in the report 'Noise Abatement in Switzerland', published in 1963. This states in its closing remarks that the realisation of its proposals will require considerable time, money and effort, but that naturally the health and well-being of the population are values for which no effort should be spared in order to secure them.

After a lapse of a quarter of a century, the Law relating to the Protection of the Environment and the Noise Abatement Ordinance came into force. The intention of the principles and provisions contained in these is to protect the public from steadily rising exposure to noise. One may ask: With what result? At what price? What was the outcome of the objective formulated in 1963 to *bring the noise nuisance under control*?

The present report contains a review of the current status of noise abatement in Switzerland. It critically examines the principles and procedures underlying it, and highlights their strengths and weaknesses. The opportunities and bounds of existing strategies are examined. Prospective approaches to noise abatement within Switzerland are also presented.

It is SAEFL's hope that the present green paper will provide a basis for discussion among those affected by noise and the professional players active in this field. This hope is coupled with a desire to create suitable conditions enabling the basic tenets of noise abatement to be more effectively and efficiently implemented. Finally, we wish to heighten public awareness of the problems involved in this sector of environmental protection.

*Philippe Roch*  
*Director of the Swiss Agency for the Environment,*  
*Forests and Landscape*



# Summary

## Objectives and procedure

The objectives of the present report are to present the current status of noise abatement in Switzerland, which is based on the Law relating to the Protection of the Environment (LPE) and the Noise Abatement Ordinance (NAO), and to critically review this. The aim is twofold: firstly to provide a documentation of the work done till now; secondly to examine objectives and strategies for possible improvements, thereby enabling potential opportunities for future noise abatement to be identified.

The basis is laid in Chapter 1, which takes a look at the beginnings of noise abatement in Switzerland. In Chapter 2, the foremost attributes of the terms 'quiet' and 'noise' are presented and the principal effects of noise summarised.

<b>Fundamentals</b>	Chapter 1 <b>The beginnings of noise abatement</b>
	Chapter 2 <b>Life amidst quiet and noise</b>
<b>Current status</b>	Chapter 3 <b>Objectives and strategies of noise abatement</b>
	Chapter 4 <b>Current status of noise abatement</b>
<b>Scope for action</b>	Chapter 5 <b>Critical review of objective and strategy</b>
	Chapter 6 <b>Procedural modes in noise abatement</b>

Chapter 3 discusses the objectives and strategies behind current noise abatement endeavours. Chapter 4 documents the current status of work in the principal areas of noise abatement.

Chapters 5 and 6 identify the scope for action in the field of noise abatement. To this end, Chapter 5 offers a critical and forward-looking analysis of objectives and strategies. Finally, Chapter 6 presents the resulting outlines of a future concept for noise abatement

policy in Switzerland.

The proposals identify the scope for action without regard to force of circumstances. Moreover, the report excludes the question of whether the proposed ideas are politically realisable.

## Fundamental considerations

### The beginnings of noise abatement

The basis for noise abatement in Switzerland was laid down by the Federal Expert Commission with the publication of its report in 1963. In this, proposals were made to the Federal Council to combat the increasingly hazardous effects of noise.

A quickly implemented measure at the time was the establishment of a new technical department at EMPA for acoustics/noise abatement. In addition, a specialised Federal Agency for

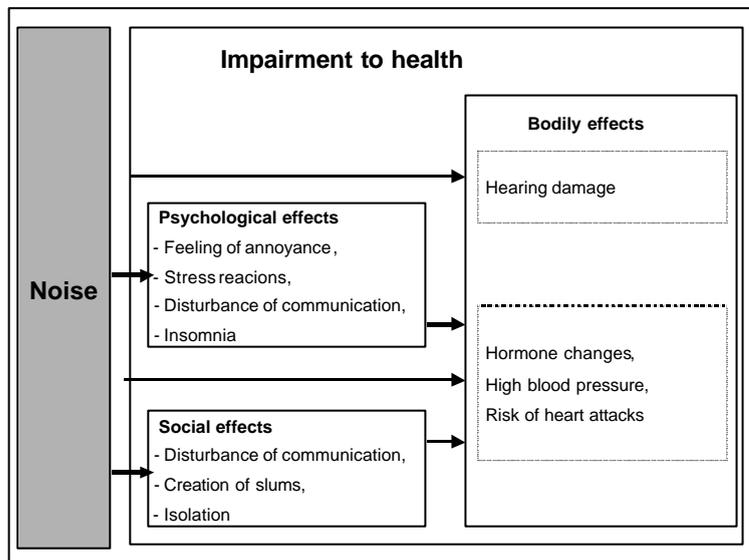
Noise Abatement was established in the former Office for Environmental Protection (now SAEFL), which played a leading role in laying down the substantial and legislative foundations. Noise abatement is based in law on the Federal Constitution and on the LPE. The LPE lays down the objectives, fundamental principles and strategies for future noise abatement policies, and these are further detailed in the NAO.

**Life amidst quiet and noise**

The state of quiet has many facets, and there is no precise and generally accepted definition for it. From surveys, the conclusion may be drawn that for large sections of the population, a state of 'quiet' is most closely approached when the noise threshold approximates to the natural background sound level. At the same time, it is clear that there is no general definition of quiet that would cover the whole population.

For those affected, noise is undesirable sound that may detract from their psychological, physical, social or economic well-being. Its multifarious effects generally increase with rising noise level.

Health is the condition most seriously effected by noise, as manifested by psychological, social and bodily reactions. Contrary to most other environmental influences, noise does not lead to the pollution of resources (i.e. air, water and soil), but instead



affects human beings directly. One advantage of this is that with noise, storage and retention effects need not be considered. From the point of view of the affected population, however, this is in fact a disadvantage, since the emissions from the various sources do not accumulate to become a threat to the entire population (as is the case for universal air pollution), but selectively affect particular regional groups or individuals at clearly defined times and places. Furthermore, these groups do not dispose of a lobby strong enough to ensure that their needs are respected by the rest of the population. As a result of lack of solidarity and available opportunities to escape noise, noise exposure has become an environmental problem with a social dimension, to which all of us contribute, but which has mainly to be borne by those at the lower end of the social scale. Environmental 'pollution' of the 'acoustic landscape', together with the health risk to the population which accompanies it, is therefore underestimated by many decision makers, who themselves can afford to flee the noise. The social impact is particularly manifest in the segregation of residential areas. In these, it may be observed that the proportion of single-person households, pensioners, foreigners and people at or below the poverty line is particularly high.

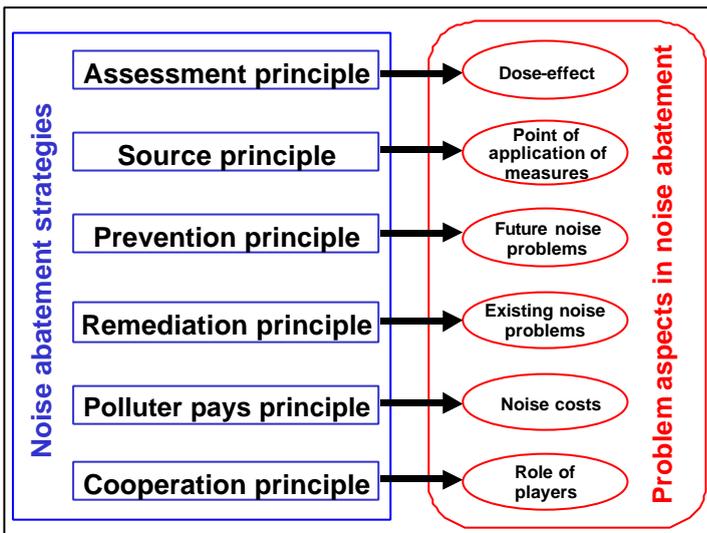
Noise also creates a financial burden. In addition to the direct costs of treatment resulting from health impairment, costs also arise from noise abatement measures, loss of production, and the efforts of those affected to flee the noise. Estimates of the total costs due to noise range from 0.2% to 2% of gross domestic product (GDP).

## Current status

### Objectives and strategies of noise abatement

The basic objective of noise abatement in Switzerland is the «protection from hazardous or undesirable effects, so that the residual exposure does not substantially affect the well-being of the population according to current technology or experience».

The strategies to achieve this objective are based on six principles that cover the main problem areas to be addressed in noise abatement.



The 'assessment principle' addresses the problem of the dose-effect relationship, i.e. of the proper assessment of noise exposure. The objective is to quantify the phenomenology of 'noise and nuisance'.

The 'source principle' lays down that noise abatement should mainly be applied at source (emission limitation).

The next two principles are concerned with avoidance of future noise problems: (a) in terms of prevention by (b) procedures for the

remediation of existing noise problems (noisy installations).

The 'polluter pays principle' addresses the question of who should pay, while the 'cooperation principle' deals with the mode of cooperation between the players.

### Current status of noise abatement

The current status of noise abatement may be illustrated based on the three functional categories: **fundamentals**, **implementation** and **flanking measures**.

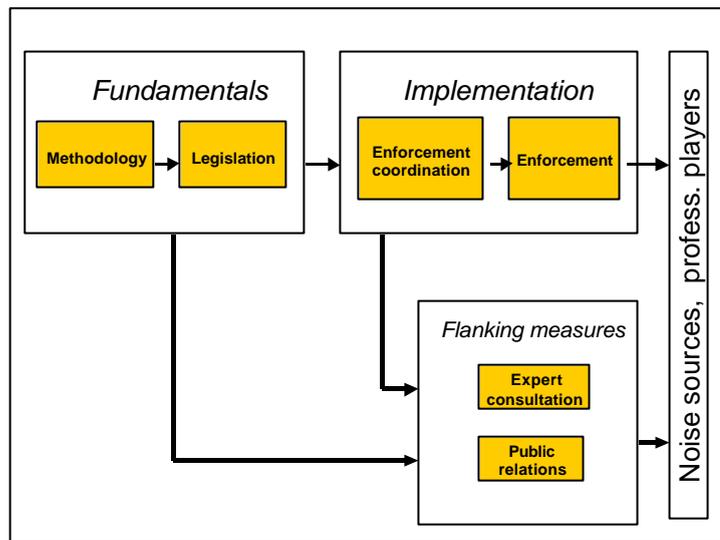
Under the **fundamentals** category, the principal approaches to noise abatement were identified. These include noise and exposure limits for the determination of the dose-effect relationship, impact thresholds for the principal types of noise, monitoring of noise exposure and the technical, structural and development planning measures for the reduction of noise and its consequences.

The legislative provisions on noise abatement contained in the LPE and the NAO are based on the underlying physical relationships.

The duties of enforcement and enforcement coordination are covered under the **implementation** category. The responsibility for enforcement of noise abatement measures lies with the environmental agencies in the 26 cantons and the Federal organisations concerned (FEDRO, FOT, FOCA, FOAFL, DDPS). The principal areas of enforcement are development planning and structural precautions, monitoring of noise exposure and remediation of noisy installations. To ensure consistent enforcement (so-called 'unité de doctrine'), SAEFL has the responsibility for coordination and training, assessment of remediation projects and controlling tasks where Federal contributions to noise protection measures on roads are concerned.

Concerning prevention, Switzerland has introduced obligatory type approval procedures for new vehicles to limit noise emission. The provisions were taken directly from EU legislation. International provisions on aircraft emission have also been adopted. Owing to Switzerland's international involvement, particularly with the EU, there is only limited scope for manoeuvre in this field. Also, the objective of development planning precautions is to preserve quiet areas and to keep new residential building away from noise-exposed areas. There is, however, a conflict between the needs of noise protection for private property and the economic interests of the owners of installations and property. In consequence, preventive noise protection often meets with vigorous opposition. In general, future noise problems may nevertheless be effectively avoided by suitable development planning.

The noise exposure registers contain estimates of the number of persons subject to noise exposure above the impact threshold for the five principal types of noise in the categories of monitoring and remediation. Some 550 000 persons are affected by road transport facilities, of which only a third have been remediated. Here, the remediation deadline will be extended and measures are planned to accelerate the process. For railway noise, remediation is just starting to protect the some 265 000 persons affected by noise above the



impact threshold. The remediation of rolling stock should be completed by 2009, and structural noise protection measures by 2015. Some 75 000 persons were affected by noise from civil firing ranges. The remediation date is open until the end of 2002, and no extension to this is intended. Remediation measures are also in hand for most of the civil and military airfields. Here, over 100 000 persons are subject to noise above the impact threshold, for whom protection will be confined in the main to the installation of noise protection windows in their houses, since more effective measures are not realisable either for technical, economic or political reasons. For industrial and trades installations, the problem is less, since the noise from these has already been significantly reduced thanks to existing regulations on noise limitation at the workplace. The noise exposure due to military firing ranges and training grounds has not yet been compiled in registers, since the exposure limits necessary for this are not available. These installations, numbering about 70, cause only modest exposure, since firstly they lie outside of residential areas, and secondly generate noise only over limited periods.

From an overall view of noise exposure, three separate situations may be identified: (a) areas close to transportation facilities with *clearly excessive noise*. Here, the noise exposure lies above the impact threshold of 60dB specified for residential areas; (b) in residential areas, there is a general tendency for the *noise exposure to approach the impact thresholds at all places*, and for very little to be done to counteract this; (c) finally, there is increasing *insidious noise exposure* of formerly *quiet areas*, particularly in the countryside, open recreation areas and areas of natural beauty.

The protection against excessive noise provided for in legislation does not include a 'right to quiet', the result being that the noise exposure at many places is increasing both in terms of areas and times affected. Taken together, these developments point to increasing noise nuisance in our living space.

In the category of **flanking measures**, the authorities, together with the EMPA, provide consultation services in the form of advice on technical, planning-related or legislative questions concerning noise protection. Further public relations activities are information and sensibilisation of the general public by personal contacts, published material and contributions to conferences.

## Scope for action

### Critical assessment of objectives and strategies

Experience with noise abatement since the NAO entered into force has shown that the strategic principles applied are basically right. On the whole, noise abatement has made relatively good progress in Switzerland, but not as good as would be necessary to provide comprehensive protection of the population.

The current situation in noise abatement – coupled with a critical assessment of objectives and strategies – indicates the following weaknesses in the areas of objectives, problem identification and problem solving:

### Objectives:

- The protection principle embodied in the LPE concentrates not so much on entire landscapes but more on living spaces inside buildings, leading on the one hand to an insidious increase in noise exposure in the countryside, and on the other to 'barricading' of the population.
- The protection from noise provided for in the LPE is weaker than in the WHO definition of health;

### Problem perception (strategy):

- The existing assessment principle is not yet sufficiently comprehensive, in other words not yet applicable to all noise situations. The quantitative assessment of disturbance, damages and costs caused by noise is not yet available in sufficiently detailed form;
- Monitoring of noise exposure in Switzerland (emissions, exposure, population affected) is inadequate for obtaining an up-to-date – overall – perspective, and is unsuitable for making international statistical comparisons.

### Problem solution (strategy):

- Existing noise protection legislation suffers from gaps;
- The problems involved in noise abatement, particularly in noise remediation, have till now been underestimated. This applies particularly to road and railway installations. For roads, additional measures to accelerate remediation are needed to enable the work to be completed within the foreseeable future;
- The polluter pays principle in the LPE is defined in a narrow sense, so that not all noise costs are covered. Furthermore, there is practically no economic incentive to reduce noise and its consequences;

- Noise abatement is heavily undermined and restricted by virtue of the exemptions that may be granted;
- Efforts to reduce noise at source, particularly for vehicles and appliances, are not being adequately pursued;
- The availability of information, and particularly of training opportunities, on noise is limited and needs to be expanded;
- The interdisciplinary nature of noise, together with the variety of different players, and the fragmented and weak noise lobby, underlie the unsatisfactory coordination of noise abatement within the country. Furthermore, noise abatement in Switzerland is only weakly coordinated with surrounding countries.

#### **Procedural modes in sound abatement**

The weak points in current noise abatement policy make it necessary to search for solutions to protect human beings more effectively and efficiently from the noise nuisance. Possible modes of procedure comprise on the one hand projects which are already at the realisation or planning stage, and on the other, new projects. The latter usually involve extensive fundamental research, legislative amendments at ordinance level, and perhaps even amendments to the LPE, making necessary prior formulation of demands and objectives at political and social level. Together, they form the scope for – i.e. courses of – action for future noise abatement in Switzerland.

Under **objectives**, there are two complementary procedural modes, which concern the extent of the areas to be protected from noise and the quality of the protection intended.

➤ **Protection of habitats:**

In the future, protection from noise must be extended to whole landscapes (including recreation areas bordering residential areas), enabling the living spaces of human beings and habitats of animals to be more effectively protected from noise. The concept of protection also includes the maintenance and extension of periods of quiet. The measures needed to do so will place significantly higher requirements on noise abatement than was till now the case, previous efforts having been based on a more technically-oriented approach. A forward-looking noise abatement policy must attempt to expand the concept of protection to embrace natural 'acoustic landscapes', and thereby to achieve a dynamic balance between the physical and acoustic landscapes.

➤ **Modification of the LPE protection concept to accord with the WHO definition of health:**

In the longer term, the LPE protection concept must be shored up to accord more thoroughly with the WHO definition of health – the decisive factor in noise abatement. To achieve more effective health protection, noise abatement must move towards the concept of a 'right to quiet'. This may be expected to have a positive impact on traffic patterns, since quieter surroundings resulting from improved noise protection of the population would reduce the need to flee from noise – one of the principal reasons for increasing traffic. The final result would be both less traffic and less noise.

Under strategies, **problem perception** involves the following two procedural modes:

➤ **Extension of the assessment principle:**

The assessment principle must be supplemented by hard-and-fast criteria to enable it to be applied to further noise categories, thereby including non-acoustic or qualitative aspects in the assessment. Further, the assessment principle must also be expanded to encompass

the simultaneous effects of different types of noise. The principle must also be extended to include vibrations and radiated structure born sound to ensure that the population is also protected in these sectors. The methods of assessment must also be refined in order to quantify the health, economic and social effects of noise.

➤ Monitoring:

Monitoring of the noise nuisance must be reinforced to provide detailed data on the extent of emissions and exposure, and the population and areas affected. The controlling procedures for recording the effects, costs and effectiveness of measures need expanding based on performance control. Detailed and up-to-date monitoring is an effective tool that will provide better information to the public and to decision makers in politics and industry on the problem of noise, and aid in sensibilising them towards the needs of noise abatement.

Under strategies, the following seven procedural modes are available for **problem solution**:

➤ Closing of legislative gaps:

When the NAO came into force, it was decided to issue regulations on emissions of vehicles and appliances, and exposure limits for the commonest types of noise. This work will be completed in the near future. Current work comprises:

- Extension of the NAO to cover assessment criteria for sports weapons;
- Legislative amendments to the noise exposure register;
- Extension of the completion dates for road noise remediation in conjunction with acceleration measures;
- Specification of exposure limits for noise from military firing ranges and training grounds;
- Additional provisions on the assessment of combined exposure to noise from military and civil airfields.
- In addition, SAEFL is preparing an ordinance on the protection of the public from vibrations and radiated structure born sound, regulations for type approval and labelling of appliances, and the establishment of emission limits for rolling stock in normal operation. SAEFL is also contributing to the revision of the SIA 181 standard on noise protection in building construction.

➤ Assuring enforcement of noise protection

Consistent enforcement of the NAO, and particularly of noise remediation measures, over the whole of Switzerland remain an important theme for the future. While railway remediation is scheduled for completion by 2015 at the latest, the deadline of 2002 for road noise remediation needs to be extended as well. This is particularly the case for roads in urban areas, since the motorways and federal highways have received priority treatment under previous measures. To guarantee the remediation of road noise within the newly extended periods, further acceleration measures must be considered.

➤ Extension of the polluter pays principle:

The polluter pays principle in the LPE must be extended to ensure that all conceivable noise costs are borne by those responsible. To do so, detailed knowledge of the costs resulting from noise is required, and available economic instruments must be deployed.

➤ More restrictive conditions on relaxation:

The relaxation loophole must be accompanied by economic and/or time restrictions to ensure more comprehensive enforcement of noise protection.

➤ More extensive noise remediation at source:

One of the most efficient measures for the universal reduction of noise exposure is the 'technical' noise reduction at source, and this must be increasingly applied. In addition to

technical measures, economic instruments in the form of incentives must be found that include not only the classical performance figures for vehicles and appliances, but also their noise characteristics. This requires that in addition to incentives and regulations to promote low-noise technologies, consultation services must be available to provide the necessary know-how, presupposing in its turn increased research effort, particularly at EMPA.

- Expansion of the information and education programme  
The information and training programme must be expanded at all levels of noise abatement in order to sensibilise the public more thoroughly to the environmental impact of noise. Also, to underpin noise abatement policy at scientific level, a procedural mode involving creation of an interdisciplinary university chair on noise is necessary.
- Coordination of noise abatement  
Owing to the strongly interdisciplinary nature of this work with its many players, resolute coordination is called for. This requires specific institutional instruments in the form of working groups, coordination commissions and obligatory reporting, including the necessary competencies, to ensure that the various areas such as enforcement, development planning, landscape protection, the economy and technical noise abatement are rendered able to collaborate efficiently and effectively. Switzerland's increasing international involvement at the political and economic levels also calls for increased international cooperation in the environmental field, enabling her not only to profit from the synergies of a consistent European noise abatement strategy, but also to take part in its development.

The next steps in implementing these procedural modes call for the concerted endeavour of all the participants and should be regarded as a communal duty. The closing remarks of the report on 'Noise Abatement in Switzerland' of 1963 remain very true today: «The realisation of the proposed modes of procedure will entail the expenditure of considerable time, money and effort, but the health and well-being of the population are values for which no effort should be spared in order to secure them.»

# 1 The beginnings of noise abatement in Switzerland

On 7 October 1963 – twenty years before the Law relating to the Protection of the Environment (LPE) was enacted – the Federal Expert Commission published its report on 'Noise Abatement in Switzerland'<sup>8</sup>, which was formally addressed to the Federal Council. This tome comprising 360 pages still remains of interest today, as it provides a good insight into the early days of noise abatement, and permits a fuller understanding to be gained of present-day efforts.

The report was initiated by a motion tabled in the National Council in 1956. In response, the Federal Council established an expert commission, which was entrusted with the task of «investigating the noise problem as comprehensively as possible from a medical, technical and legal standpoint, and to propose legislative measures on noise abatement to the Federal Council.

This very large commission comprising 52 members succeeded in producing an impressive basic document on noise abatement in Switzerland. From a present-day standpoint, the following points are of particular relevance:

- The report established an initial basis for the Noise Abatement Ordinance (NAO) which followed. It contains the fundamentals underlying the modern concept of impact thresholds, divided according to day and night, development planning considerations (differentiation between industrial and residential zones), and also specifies provisional impact thresholds (Fig. 1.1).

Cat. No.	Background noises		Frequent maxima		Infrequent maxima		Desired zonal designation
	Night	Day	Night	Day	Night	Day	
I	35	45	45	50	55	55	Convalescence zone
II	45	55	55	65	65	70	Quiet residential zone
III	45	60	55	70	65	75	Mixed zone
IV	50	60	60	70	65	75	Commercial zone
V	55	65	60	75	70	80	Industrial zone
VI	60	70	70	80	80	90	Main transport route

*Desired values:* 10dB lower, but not below 30dB(A).  
*Background noise:* Average value (average level excluding noise peaks).  
*Frequent peaks:* 7-60 noise peaks per hour.  
*Infrequent peaks:* 1-6 noise peaks per hour.

**Fig. 1.1**  
Commission proposal (1963) for a scheme of exposure limits for noise exposure.

- The specific questions arising from the different types of noise – ranging from road noise to that from milk churns – were analysed in sub-commissions. These investigated the peculiarities of noise in the areas of source characteristics, noise propagation and measurement

and assessment problems, and tabled proposals for measures to solve these. The Noise Abatement Ordinance (NAO), which entered into force in 1987, also embraces a differentiation between types of noise, and lays down threshold values for the most important sources.

- The interdependency of noise abatement and development planning is emphasised, and the segregation of noisy plant and residential areas demanded. Although the commission makes a number of concrete proposals, it takes a somewhat defeatist attitude, maintaining that it would «hardly be possible to establish specific legislative provisions for the inclusion of noise abatement in planning procedures. ... The main requirement is that noise abatement always be considered in zonal planning, building legislation and regulations, road-building legislation, etc.». This formulation relativises the combating of noise in this core area, albeit in veiled form.
- In place of a Federal law on noise, the commission proposed that the question of noise abatement be included in other laws and ordinances when these are amended.
- The commission nevertheless prepared a draft ordinance on noise protection. This was based on a catalogue of directives for action and measures: «Effective noise abatement requires that the sources of noise be enumerated, thereby providing the citizens and the police with utilisable procedures».
- In the early stages of its work, the commission suggested the establishment of a Federal research, testing and consultation centre for noise abatement. In prior anticipation of this proposal, the Confederation established the Department of Acoustics/Noise Abatement at the EMPA in Dübendorf with the duty to be «ready to assist the authorities and private instances by means of studies, expertises, consultations, etc.», and which was later to be «further extended».
- The commission also suggested two institutional measures:
  - Nomination of a 'noise abatement delegate', whose tasks corresponded partly to those of the present head of the Department of Noise Abatement at SAEFL.
  - Recommendation to the cantons to establish coordination centres for noise questions, now realised in all cantons.
- In total, the commission recognised noise abatement to be a complex interdisciplinary problem, involving teaching methods and the public interest.

This early report is characterised by a belief in the feasibility of noise reduction by technical means, and by a reliance on legislative directives addressed to the public and the police. It considers neither the question of the civilisational causes of noise, nor that of quantitative growth, especially in connection with mobility. The polluter pays principle is not perceived in its collective dimension. The commission nevertheless declares the need for quiet to be an incontestable value, without however defining precisely what is meant by this term. The report goes on to assert that «a determined effort by the state is necessary to master the noise plague».

Forty years on, we are obliged to admit that neither society nor the state have yet mastered the noise 'plague'. Indeed, the present report would have been unnecessary if the conflicts of interest between the various parties had already been resolved.

Following publication of the report, the Confederation commenced with the extension and implementation of the proposals contained in it. Thus the Department of Noise Abatement was established within the former Federal Office for Environmental Protection (AfU, now SAEFL), and charged with establishing the necessary material and legislative basis. In law, noise abatement rests upon Article 24<sup>septies</sup> of the Federal Constitution, which was introduced in 1971 (from 1999: Article 74), and this formed the basis of the Law relating to the Protection of the Environment (LPE), which came into force in 1985. The objectives and fundamental principles (strategies) for future noise abatement were an integral part of the legislative provisions contained in the LPE, which covered all the main environmental sectors, and were further detailed in the Noise Abatement Ordinance of 1987.

The basic objective of noise abatement in Switzerland today is the «protection from hazardous or undesirable effects, so that the residual exposure does not substantially affect the well-being of the population according to current technology or experience»..

The present report takes a critical look at these aims. It enquires into the relationship between theory and practice and poses the question as to what measures might be necessary to achieve the intended goals. It is not the intention here to present ready-made solutions, but to provide a 'green book on noise abatement ' as a basis of discussion in Switzerland. It discusses existing problem areas and presents workable modes of procedure.



## 2 Life amidst quiet and noise

### 2.1 What is quiet? What is noise?

#### 2.1.1 Discussion of the term 'quiet'

The term 'quiet' cannot be defined as precisely as noise. Is quiet simply the absence of noise? Must the *finale* to Ravel's Bolero be classified as noise? If not, does it correspond to quiet? This can hardly be the case! Clearly, therefore, quiet must be more than the mere absence of noise. But how could it be defined?

In a representative survey of the Swiss population, Lorenz<sup>17</sup> distinguishes between the 'acoustic' and 'psychological' definitions of quiet (Fig. 2.1).

From an acoustic point of view, it was shown that almost half those questioned associated quiet primarily with natural sounds – i.e. not so much with the mere absence of noise. The concept of quiet is also strongly associated with the psychological and physical well-being of human beings. It is also a synonym for inner peace. However, to find peace within oneself is often difficult amidst the everyday rush and tumble, stress and noise. The psychological inquiry into quiet also generates some interesting facts. Thus for over half those questioned, quiet signifies relaxation and recreation, and for one-third, well-being. Unfortunately, the study contains no data on the connection between these observations and the actual acoustic exposure.

Almost three-quarters of those questioned named the countryside as a place of quiet, and some two-thirds had recourse to their homes for this (Fig. 2.2). No distinction was made in the survey between spaces inside and outside buildings, such as balconies and gardens. It may safely be assumed that those questioned used the term 'at home' in an general sense, not simply to mean inside the building.

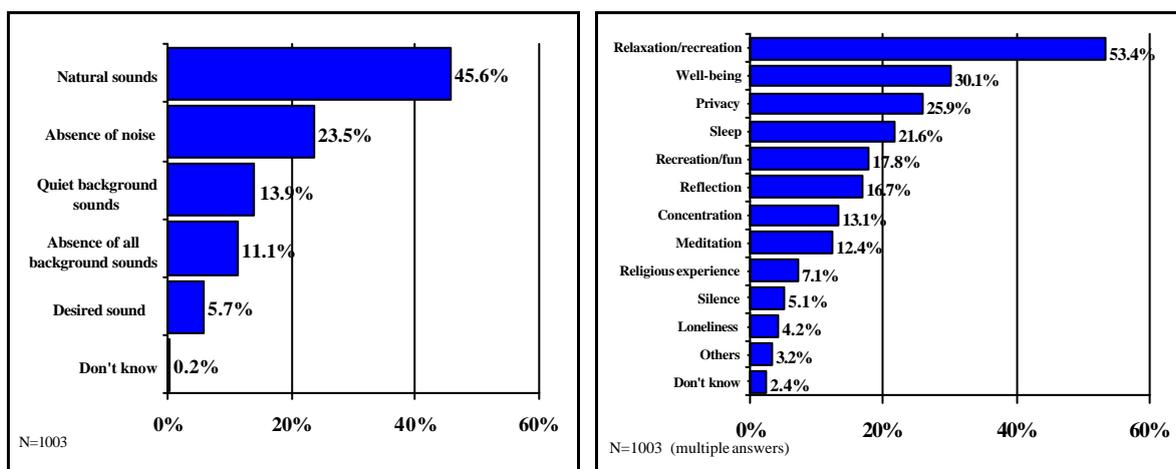
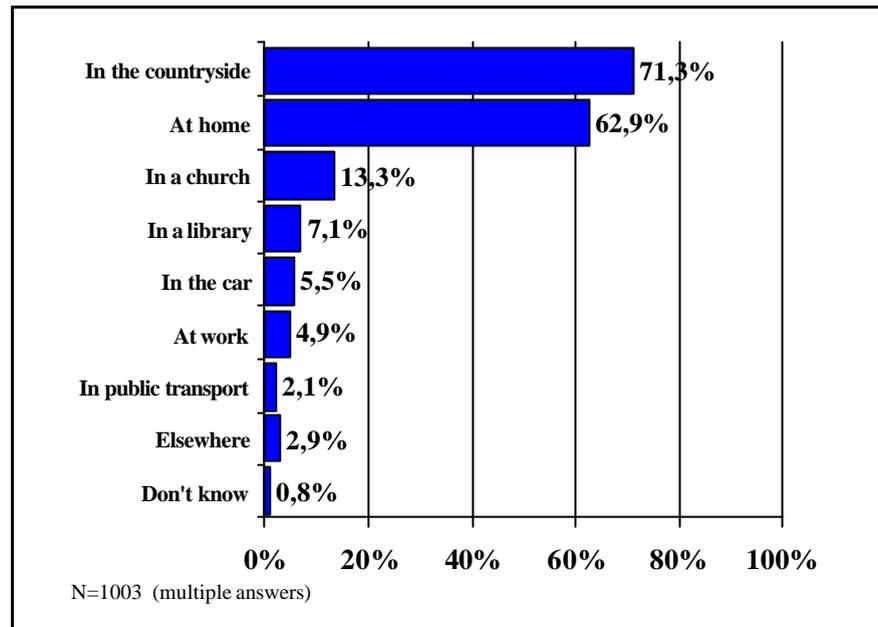


Fig. 2.1

Acoustic (at left) and psychological (at right) definitions of quiet according to Lorenz<sup>17</sup>.

Quiet, therefore, is a state having multiple aspects. It is therefore not surprising that there is no simple and generally acknowledged definition for the term. The conclusion may be drawn from surveys that for large sections of the population, a state of 'quiet' is most closely approached when the noise threshold approximates to the natural sound background. At the same time, it is clear that no general definition of quiet covering the whole population can be given. This is because the attitudes and needs of individuals differ so greatly.

**Fig. 2.2**  
Places of tranquillity according to a survey by Lorenz<sup>17</sup>.



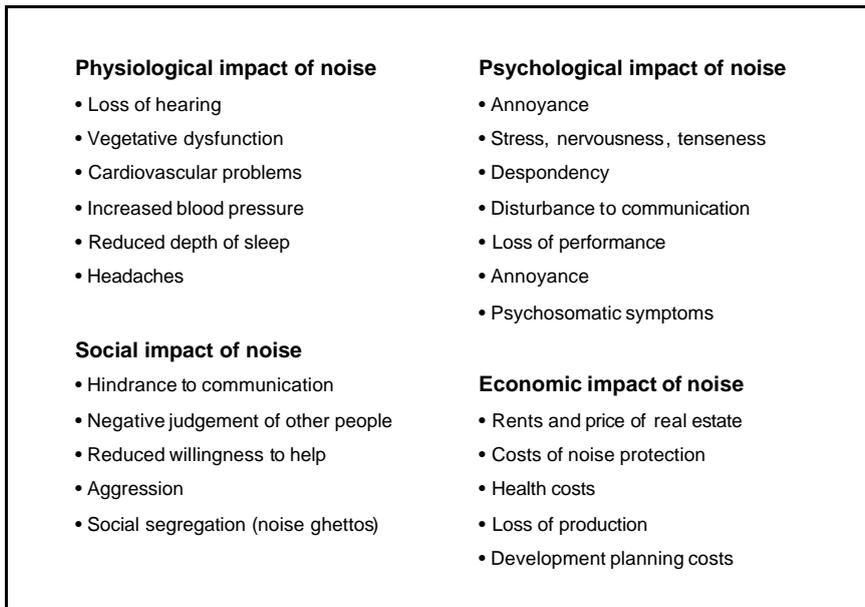
### 2.1.2 Definition of noise

For those affected, noise is undesirable sound that may detract from their psychological, physical, social or economic well-being. Noise not only has a physical aspect but also, since the perception of it differs for each individual, a socio-psychological component (i.e. socio-scientific aspect). In its negative connotation, 'noise' signifies both nuisance and disturbance, and thereby carries with it a possible health hazard. The medical aspects must therefore be included within the study of noise.

## 2.2 Impact of noise

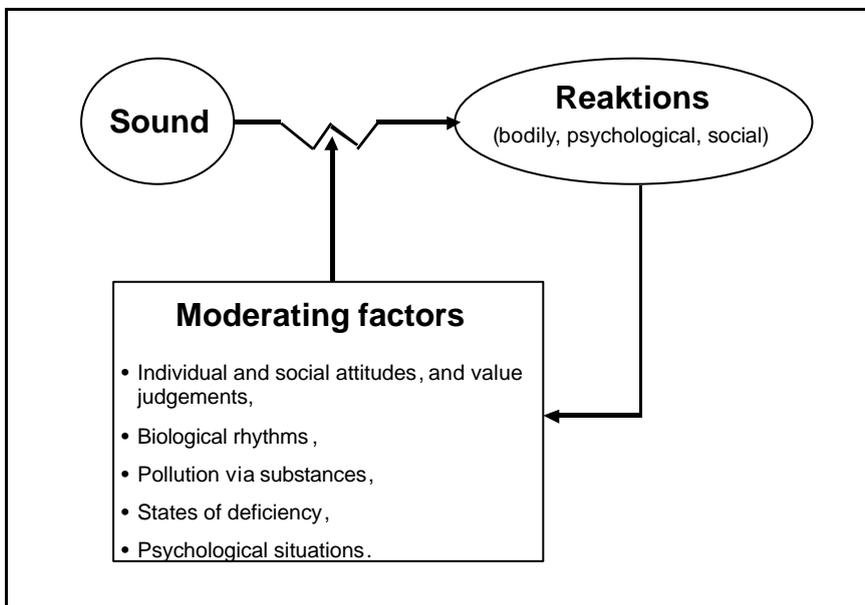
Noise has a variety of effects whose duration and intensity generally increase with higher sound pressure level. Fig. 2.3 provides a breakdown of the main impacts.

Except for very high sound levels at which direct damage to the hearing can occur, it is difficult to establish a positive relationship between cause and effect. This is because the (subjective) disturbance varies strongly from one person to another and depends to a large extent on non-acoustic factors. Also, the relationship between cause (sound) and effect (reaction) is indirect, and is heavily influenced by moderating factors such as individual attitudes to sound, biological rhythms and sociological factors (Fig. 2.4).



**Fig. 2.3**  
Breakdown of the principal noise impacts.

The disturbance due to a sound 'event' can therefore be only partly attributed to the intensity of the sound, quoted values of statistical variance lying between 10 and 30% depending on the particular study. Since the reaction, i.e. disturbance, depends not solely on the physical magnitude of the cause, practical noise abatement is faced with substantial problems in establishing impact thresholds. This finding also lies at the root of the conflicts associated with noise.



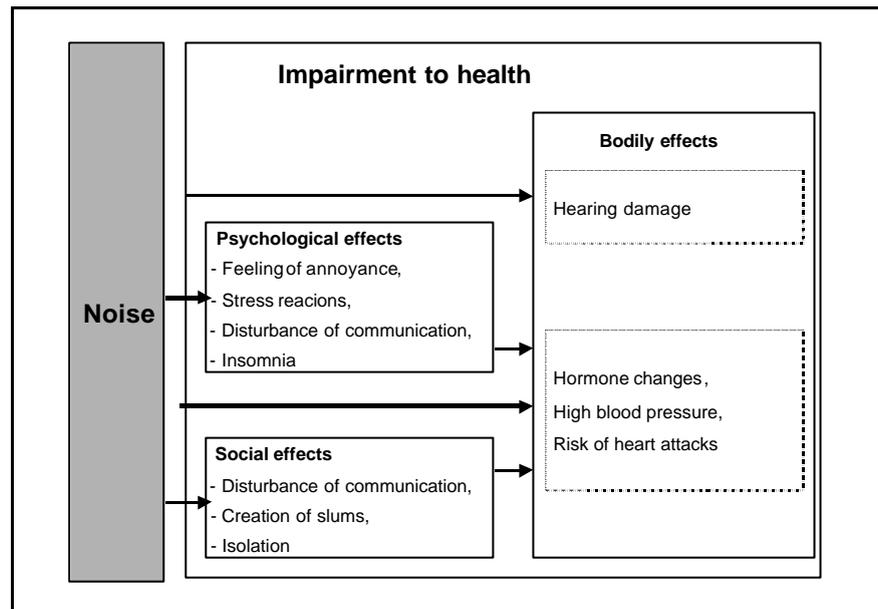
**Fig. 2.4**  
Relationship between cause (sound, noise) and effect (reaction of persons).

In the following, the principal aspects of the health, economic and social impacts are presented.

## 2.2.1 Impact on health

The World Health Organisation (WHO) defines health as «a state of complete bodily, mental and social well-being», which therefore goes beyond the mere absence of illness. Further, the WHO defines this state of health «in its highest achievable form» to be a fundamental right of each and every human being<sup>25</sup>. This definition implies that health hazards must be sought not only in bodily and objectively diagnosable impairments to health, but also in the subjective detriment to our well-being, which in the long term can itself lead to bodily symptoms (Fig. 2.5).

**Fig. 2.5**  
Breakdown of the health hazards due to noise.

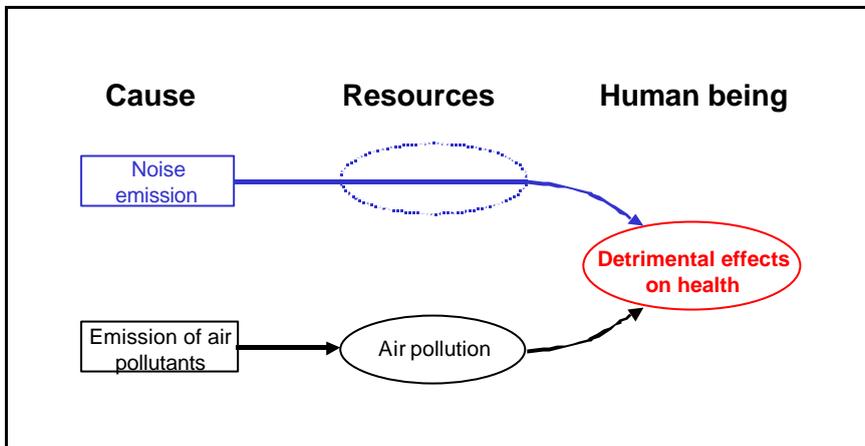


The impact of noise on bodily function may be divided into aural (i.e. relating to the ear) and extra-aural effects. Aural damage usually occurs in the form of ear complaints resulting from high sound pressure levels. Direct damage to the ear occurs particularly as a result of recreational activities (e.g. discos, sports weapons, fireworks) and noise at the workplace (e.g. at building sites), where high sound pressure levels occur. Here, the exposure time plays a significant role: exposure to 105dB(A) for just short of five minutes – for example in a disco – presents approximately the same threat to the hearing as exposure to 85dB(A) over eight hours.

In the field of environmental protection, aural damage resulting from noise exposure plays a subordinate role, since here, extremely high sound levels combined with long exposure times are the exception. The most significant effects of noise are those occurring at low to medium sound pressure levels. In practice, noise abatement concentrates on the extra-aural effects of noise, which manifest as negative psychological, social and bodily effects on human beings. Under the WHO definition, these all have a bearing on health. Thus noise, which is the cause of these, must be combated not only when bodily effects arise, but also in the case of psychological symptoms. This is particularly true for noise at night and at other times of quiet.

Changes in bodily function may occur that are not always consciously realised. Studies on persons asleep have shown hormone changes in the body due to noise. Irrespective of any personal inkling that noise does not represent a disturbance, or that one has become accustomed to it, there is no guarantee that health effects will not arise in the long term. Reviews of the health effects are to be found in the literature<sup>20, 26</sup> and elsewhere.

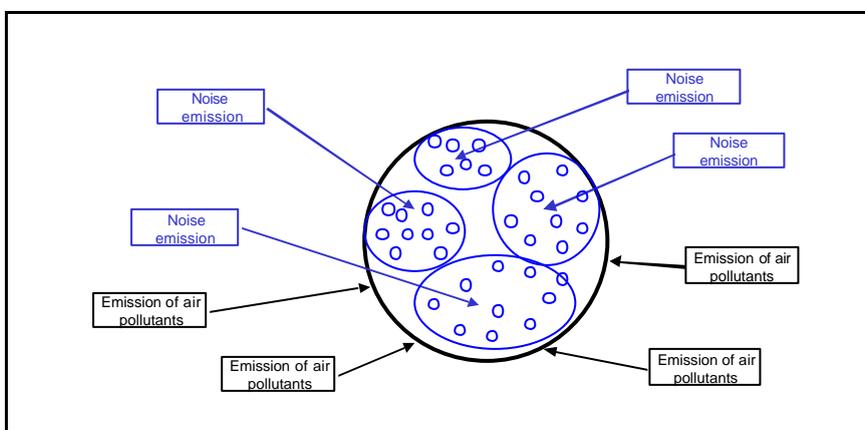
A comparison of the detrimental effects on health with other negative environmental influences is of interest. Fig. 2.6 illustrates the significant difference in the cause and effect relationships applying to noise nuisance and air pollution.



**Fig. 2.6**  
Comparison of the cause and effect relationships for noise and air pollution.

Contrary to air pollution (and most other environmental influences), noise does not lead to pollution of resources in the classical sense. Noise emission affects human beings directly, while air pollution affects the population via the medium 'air'. An advantage of this is that with noise, storage and retention effects do not have to be considered. From the point of view of the affected population, however, this is a disadvantage, since the emissions from the various sources do not accumulate to become a threat to the entire population, but selectively affect particular regional groups or individuals at clearly defined times and places.

Furthermore, these groups do not have a lobby strong enough to ensure that their needs are respected by the rest of the population. This explains why although there is a strong national and international lobby for air pollution control, this is not the case for noise abatement, despite the fact that noise causes considerable detriment to health. As a result of the lack of solidarity and the opportunities that exist to escape from noise, noise exposure has become an environmental problem with a social dimension, to which all of us contribute, but which has mainly to be borne by those at the lower end of the social scale.



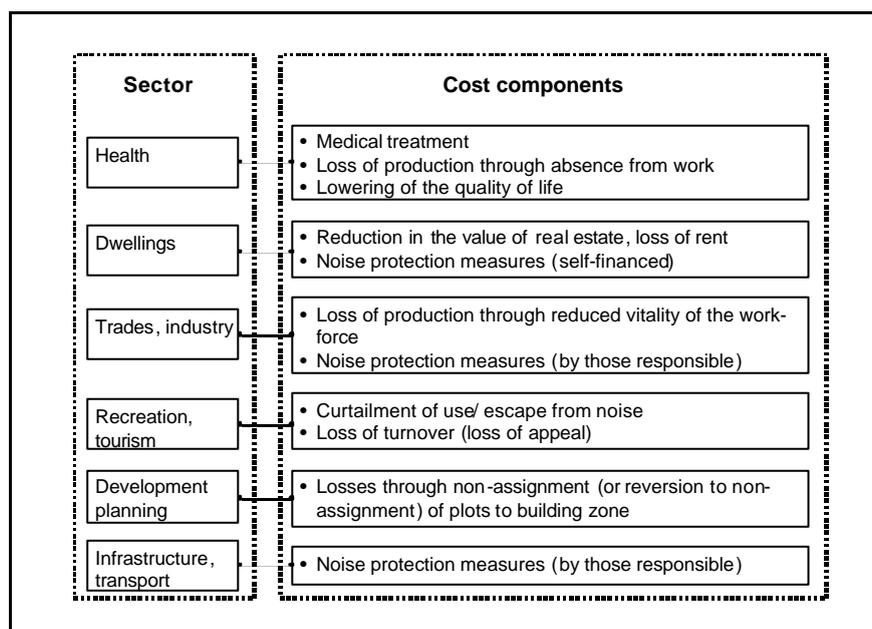
**Fig. 2.7**  
Air pollution from various sources accumulates to a threat to the entire population whereas noise pollution from different sources selectively affect particular regional groups or individuals at clearly defined times.

Environmental 'pollution' of the 'acoustic landscape', together with the health risk to the population which accompanies it, is therefore underestimated by many decision makers, who themselves can afford to flee the noise, and in spite of the fact that noise not only affects the health of the present generation, but will also affect that of coming generations. It is surprising that although there is little hope of a radical improvement in the noise situation, worldwide efforts to improve noise abatement in connection with efforts to achieve sustainable development are almost entirely lacking. In common with other environmental protection endeavours, noise abatement must, of course, be included in efforts to achieve sustainable development.

## 2.2.2 Economic impact

In a similar way to the health effects, the economic costs of noise are often underestimated. In addition to the costs of treatment resulting from health impairment, and the costs for noise abatement measures, negative economic effects also occur in other areas. A breakdown of the areas concerned and their cost components is given in Fig. 2.8.

For many areas, analytical models enabling precise quantification of the economic effects of noise are lacking. It is often not possible to specify the costs of noise, which are then carried by the community under so-called 'external' costs.



**Fig. 2.8**  
Breakdown of the principal cost components of the areas affected by noise.

The European Commission Green Paper<sup>11</sup> estimates the cost of noise at 0.2% to 2% of GDP based on a wide range of studies. With a gross domestic product of 400 billion Swiss francs in 2000, this amounts to noise costs in Switzerland between 800 million and 8 billion Swiss francs. In a further study, the external costs of road and railway noise were calculated for Switzerland<sup>7</sup>. This estimates the costs of noise resulting from these two transport systems alone over 1 billion Swiss francs per year.

### 2.2.3 Social impact

Concerning the social implications of noise, in addition to disturbances to communication and changes in social attitudes of those affected by noise, the segregation attributed to noise in residential areas is of interest here. In fact there are many indications that in areas close to noisy industrial premises and transportation facilities the proportion of single-person households, pensioners, foreigners and people at or below the poverty line is particularly high<sup>1,6</sup>. However, very little empirical evidence exists (the question of noise as a social problem is discussed in Chap. 2.2.1).

It should not be assumed from the above that there is a monocausal relationship between noise and social segregation – the latter also has a historical connotation. The upheavals in social structure that commenced in the 1960s, involving increasing separation between home and work, and also the dislocation of shopping and recreation facilities to the outskirts, led to a functional division between town and country. This process led to changes in population structure, made possible both by increasing mobility, first on the roads, and later by rail. The result was an exacerbation of the environmental situation in areas bordering the main transport routes in the towns and conurbations, and led, in its turn, to an acceleration of the cycle: structural change – transport expansion – environmental impact – structural change.

The negative dynamics of structural change often lead to serious social problems in residential areas. However, these may usually only partly be attributed to noise. In exceptional cases, for example where there is an unexpected and massive increase in noise – for example for new road and railway construction or new flight routing – noise may be the direct cause. Here, it is quite possible for insidious segregation processes to be causally triggered by noise.

## 2.3 Scope

In Switzerland, noise abatement has traditionally been divided into 'noise at the workplace', 'hazardous noise from public performances', 'neighbourhood noise and noise in homes', 'exterior noise from installations' and 'vibrations and radiated structure born sound'.

Noise at the workplace is covered by legislation on employee protection (see Annex B) and managed by the Swiss National Accident Insurance Organization (SUVA). The Swiss Federal Office of Public Health (SFOPH) is responsible for hazardous noise exposure from electronically amplified music at performances such as discos and concerts. This is covered by the Sound and Laser Ordinance. Neighbourhood noise and noise in homes is dealt with in communal regulations and regulations for rented accommodation.

In conjunction with other enforcement authorities in the Confederation and the cantons, SAEFL is responsible for management of noise abatement for exterior noise from installations, as well as for vibrations and radiated structure born sound. In distinction to noise abatement, the greater part of the technical and legislative documentation needed for protection from vibrations is still in preparation. For vibrations caused by railway installations, a directive already exists. A comprehensive ordinance is now in preparation to cover all aspects of vibrations and radiated structure born sound.

**The present report focuses on noise abatement for 'exterior noise from installations'.**

This covers noise from roads, railways, airfields, trades and industrial installations, civil firing ranges and military training grounds and firing ranges. In recent times, the term 'installation' has been used in an increasingly wide sense. Thus not only the above installations, but other sources of noise such as children's playgrounds and youth centres, have been described in court rulings as installations under the LPE.

## 3 Objective and strategy of noise abatement in Switzerland

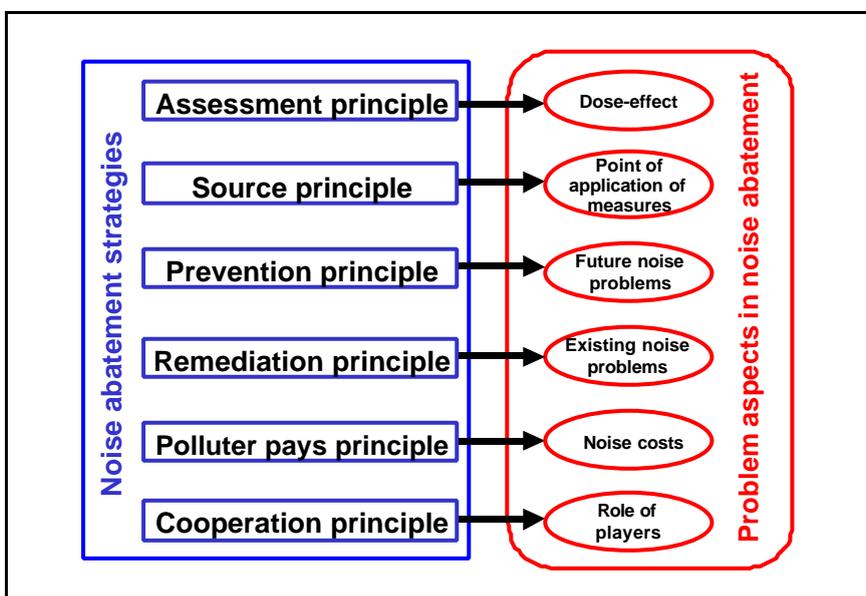
### 3.1 Objectives of noise abatement

The basic objective of noise abatement according to the Law relating to the Protection of the Environment is the «protection from hazardous or undesirable effects, so that the residual exposure does not substantially affect the well-being of the population according to current technology or experience»<sup>23</sup>.

This objective is clearly directed towards protection of human beings, although neither the term 'population' nor the broader circumstances (i.e. time and place) are specified in detail. Also, the noise protection provided is not comprehensive, and only comes into play when there is a significant impact on well-being.

### 3.2 The six principles of noise abatement

The strategy for achieving the objectives of noise abatement is illustrated in Fig. 3.1. This consists of six principles covering the main problem aspects of noise abatement.



**Fig. 3.1**  
The six basic principles underlying the noise abatement strategy in Switzerland.

The first principle addresses the problem of the dose-effect relationship, i.e. of the proper assessment of noise exposure. The objective is to quantify the phenomenology of 'noise and nuisance'. The second principle addresses the problem of the dose-effect relationship, i.e. of the proper assessment of noise exposure. The next two principles are concerned with the avoidance of future noise problems: (a) in terms of prevention by (b) procedures for the remediation of existing noise problems (noisy installations). The fifth principle addresses the question of who should pay, while the sixth principle deals with the mode of cooperation between the players.

### 3.2.1 Assessment principle

Noise impact in Switzerland is quantified for the most frequent types of noise by the rating sound level,  $L_r$ . This is based on an acoustic threshold and a correction factor  $K$ . The correction factor accounts for the specific disturbance characteristics of the noise (see Annex A).

Noise impact is assessed using a set of three exposure limits as follows:

- Impact threshold:  
According to the  $LPE^{23}$ , the impact thresholds are to be specified low enough to ensure that the well-being of the population is not substantially affected according to current technology or experience.
- Planning values:  
Planning values are specified in connection with the planning of new building zones, and for new, noisy, stationary installations. They lie below the impact thresholds.
- Alarm values:  
*Alarm values are specified to aid in assessing the urgency of remediation of noisy installations. They lie above the impact thresholds.*

To ensure increased quiet at night-time, the exposure limits during this period (22.00 to 06.00 hours) are usually set lower than those during day-time (06.00 to 22.00 hours). They are also dependent on the type of noise (road noise, railway noise, aircraft noise, etc.).

To account for their different sensitivity to noise disturbance, in development planning the different uses are divided into four sensitivity categories as follows:

- Sensitivity category I (ES I):  
Zones with high sensitivity to noise, namely recreation areas.
- Sensitivity category II (ES II):  
Zones free of disturbing installations, namely residential areas and those for public buildings and installations.
- Sensitivity category III (ES III):  
Zones with limited noise impact, namely combined residential and industrial zones (mixed zones) and agricultural areas.
- Sensitivity category IV (ES IV):  
Zones with heavy noise impact, namely industrial zones.

Consequent on the higher sensitivity to noise in recreation areas, stricter exposure limits are specified for these (see for example Fig. 3.2) than for industrial zones. The sensitivity category must always be chosen based on the use concerned.

Rating sound level  $L_r$   
 Day:=06-22 Uhr; Night:=22-06 Uhr

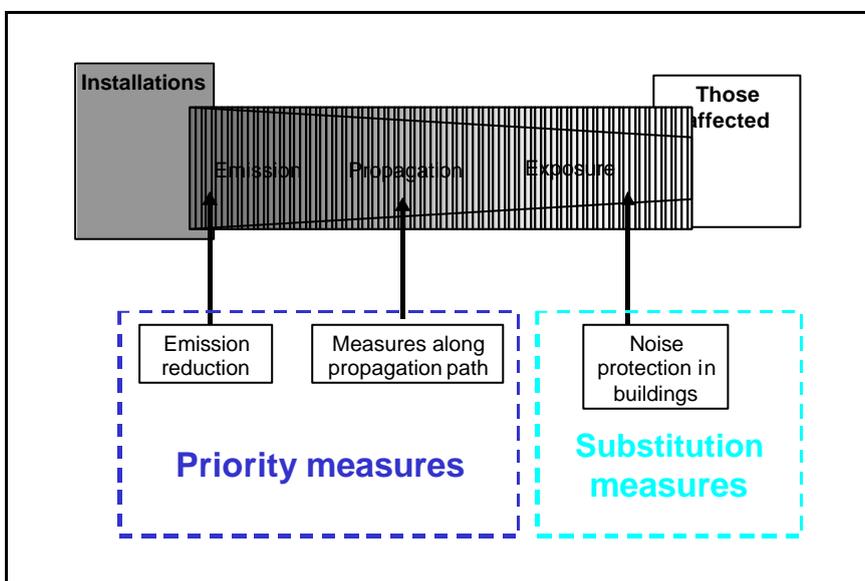
Sensitivity category	Planning value		Impact threshold		Alarm value	
	Day	Night	Day	Night	Day	Night
ES I	50	40	55	45	65	60
ES II	55	45	60	50	70	65
ES III	60	50	65	55	70	65
ES IV	65	55	70	60	75	70

**Fig. 3.2**  
 Impact thresholds according to the Noise Abatement Ordinance (example for road noise).

Residential areas may be assigned to ESIII instead of ESII if the area concerned is already subject to noise. If no exposure limits are specified, as for example with music or voices, the exposure must be assessed on a case-by-case basis according to the potential impact.

### 3.2.2 Source principle

The source principle requires that noise abatement take place primarily at source. Ideally, it is best for the noise not to be produced at all, in which case noise protection measures are obviated.

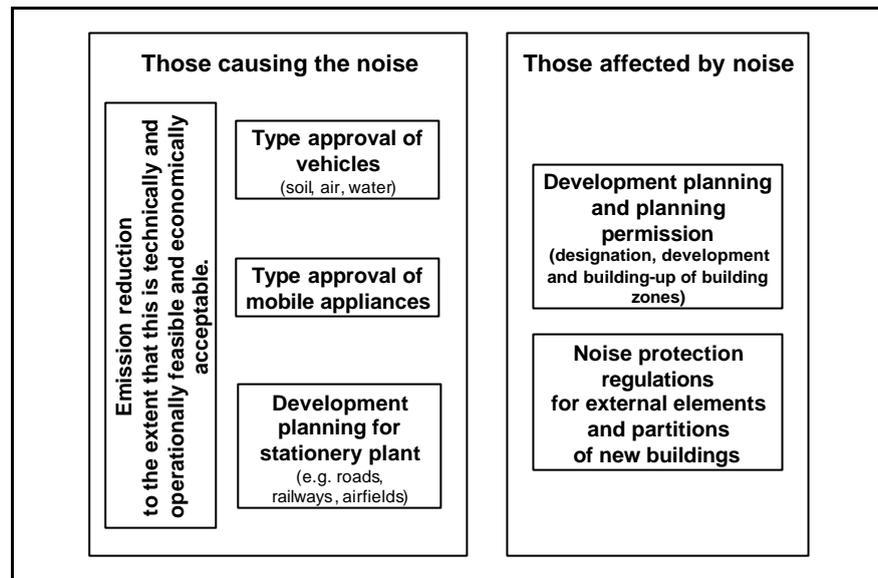


**Fig. 3.3**  
 Procedure for the application of noise abatement measures.

If measures at source should prove impracticable or would lead to unacceptable costs, substitution measures in the form of noise protection of the buildings are applied as a second option. Although this has no effect on exposure outside the building, noise protection of this sort at least protects the persons inside, permitting a certain degree of quiet.

### 3.2.3 Prevention principle

The prevention principle is intended to limit noise emission at source and to avoid future problems arising in connection with buildings in noisy areas with rooms sensitive to noise (Fig. 3.4). Measures at source, i.e. those applied to the cause of the noise are always to be preferred to those on the exposure side.



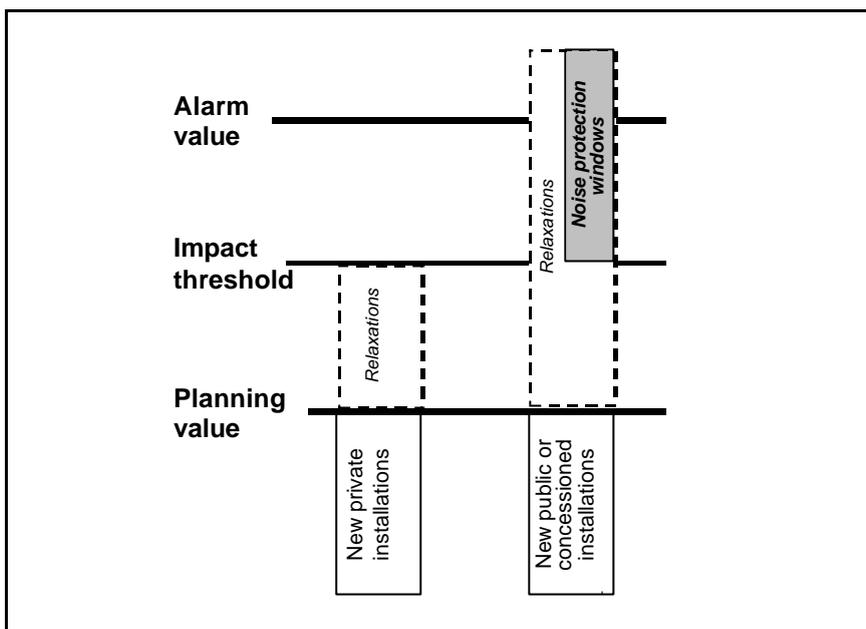
**Fig. 3.4**  
Prevention procedures  
for noise abatement.

On the causation side, there is a fundamental obligation to limit the noise emitted from vehicles, appliances and installations to the degree that this is technically and operationally feasible and economically acceptable. For installations, more stringent measures must be taken if the exposure limits are exceeded.

For vehicles and appliances, prevention is assured through type approval. In development planning, prevention is divided into the categories of 'new installations' (causation of noise) and 'new buildings with rooms sensitive to noise' (i.e. those affected by noise).

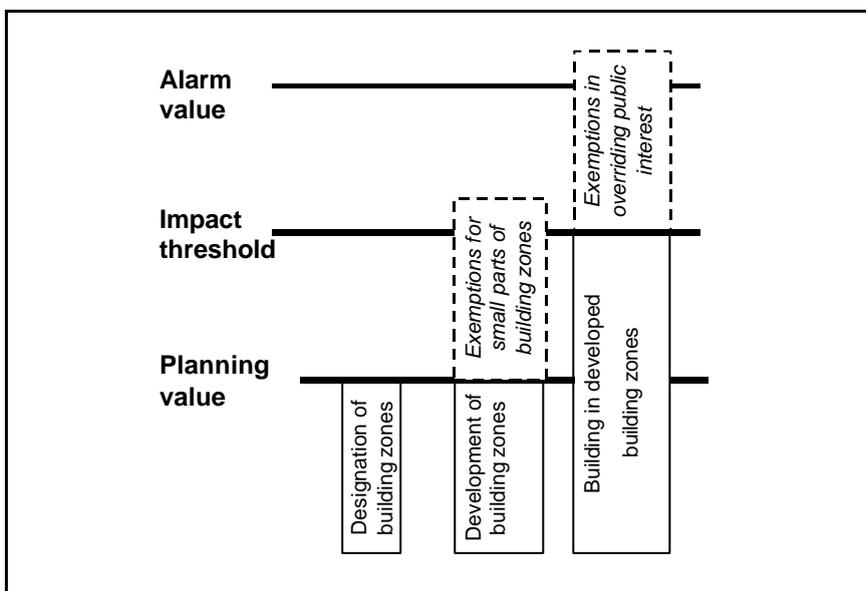
For new installations (i.e. those which were granted planning permission after 1.1.1985), the planning values (which are the strictest limits) must be complied with (Fig. 3.5). The purpose of this is to ensure that the impact thresholds are not exceeded even where several installations are built. However, the planning values must not always be complied with. Thus the enforcement authorities may relax the requirements if the measures necessary to comply with the planning values would lead to unacceptable costs. For private installations, relaxation up to the impact threshold may be granted, while for public or concessioned installations, it may go beyond this. However, if the impact thresholds are exceeded, noise protection measures (in the form of noise protection windows) must be taken in the buildings of those effected at the expense of those responsible for the noise.

The provision of additional relaxations for public and concessioned installations was decided on in the public interest. Parliament regards this as being of greater importance than providing for the quiet of local residents.



**Fig. 3.5**  
Application of the prevention principle for new installations.

For the construction of new buildings with rooms sensitive to noise, there exist preventive restrictions for the designation and development of building zones in areas affected by noise (Fig. 3.6). The designation of building zones for buildings of this type is only permitted if the planning values are complied with. The same applies to the development of building zones, whereby the authorities may grant exemptions for smaller areas. The development of building zones is only permitted on condition that the impact thresholds are complied with. Exemptions may be granted if there is an overriding public interest.



**Fig. 3.6**  
Application of the prevention principle for new buildings with rooms sensitive to noise.

In development planning, the prevention principle is one of the most important, enabling noise problems to be avoided at an early stage. However, effective noise protection requires sufficient space, and this is a scarce commodity in Switzerland. Potentially, this can lead to conflict with other development requirements. Also, the price of land in building zones is high, so that

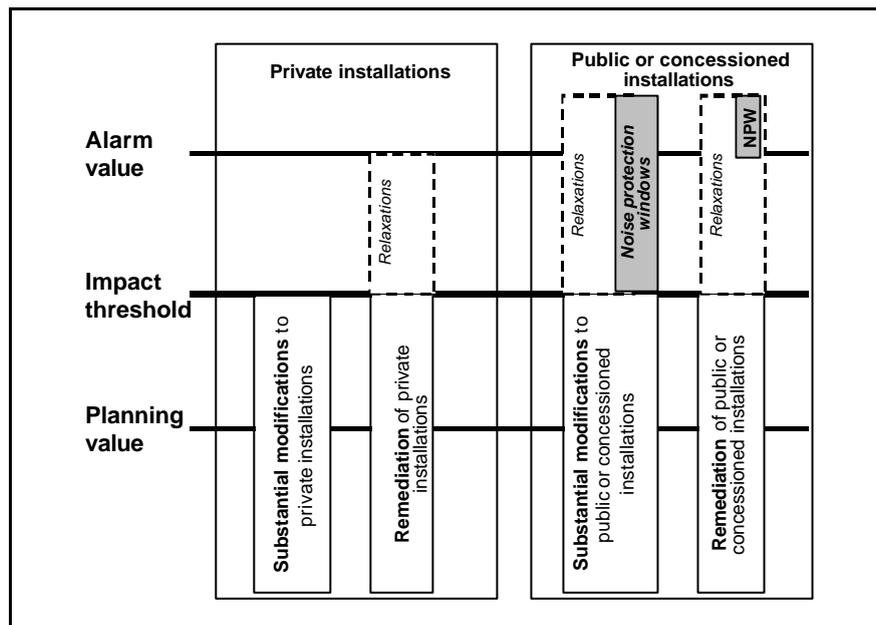
economic interests often militate against the exposure protection objectives underlying noise policy. Thus although implementation of the prevention principle in development planning is desirable and justified, political considerations can often make it difficult to enforce.

In designing new buildings, noise from within and outside the building must be considered from a preventive standpoint. Both the building envelope and internal partitions must satisfy minimum noise protection standards. For these, the NAO makes reference to SIA standard 181<sup>22</sup>.

### 3.2.4 Remediation principle

In remediating noisy installations built in the past (for which planning permission was granted before 1.1.1985), a distinction is made between private and public and concessioned installations (Fig. 3.7).

Private installations must always comply with the impact thresholds. If they do not, remediation is obligatory. Should this result in unacceptable costs, the requirements may be relaxed up to the alarm values.



**Fig. 3.7**  
Breakdown of the remediation principle for private and public and concessioned installations.

If a private installation subject to remediation is significantly altered, this must be accompanied by remediation to reduce noise exposure below the impact thresholds. Here, no further exemptions may be granted.

With public or concessioned installations (e.g. roads and airfields), remediation is also necessary if the exposure exceeds the impact thresholds. If there is an overriding public interest, the requirements may be relaxed up to and beyond the alarm values. If the exposure exceeds the alarm values, noise protection measures must be taken in the buildings affected at the expense of the owners of the installation.

The situation is similar for significant changes. Here too, the requirements may be relaxed up to and beyond the alarm values, whereby however, noise protection windows must be provided if the exposure exceeds the impact thresholds at the expense of the owners of the installation.

Note that the freedom to grant exemptions goes considerably further for public and concessioned installations than for private installations.

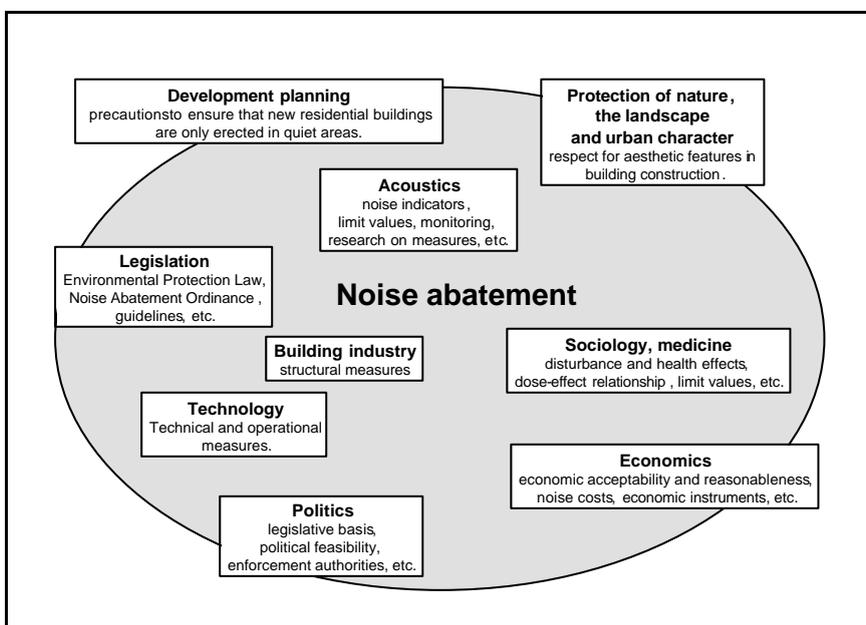
### 3.2.5 Polluter pays principle

The polluter pays principle in the Law relating to the Protection of the Environment specifies that costs that arise as a result of measures under the law must be borne by the perpetrator. As far as noise abatement is concerned, these normally only comprise expenditure for noise protection measures. Thus as the cost breakdown in Chapter 2.2.2 (Fig. 2.8) shows, the polluter pays principle does not normally cover the total cost.

If it is intended that costs other than those of noise protection measures be borne by the perpetrator, this may be enforced under other legislation (e.g. compensation payments under the expropriation legislation).

### 3.2.6 Cooperation principle

Noise abatement is a highly interdisciplinary field in which many different areas are involved (Fig. 3.8).

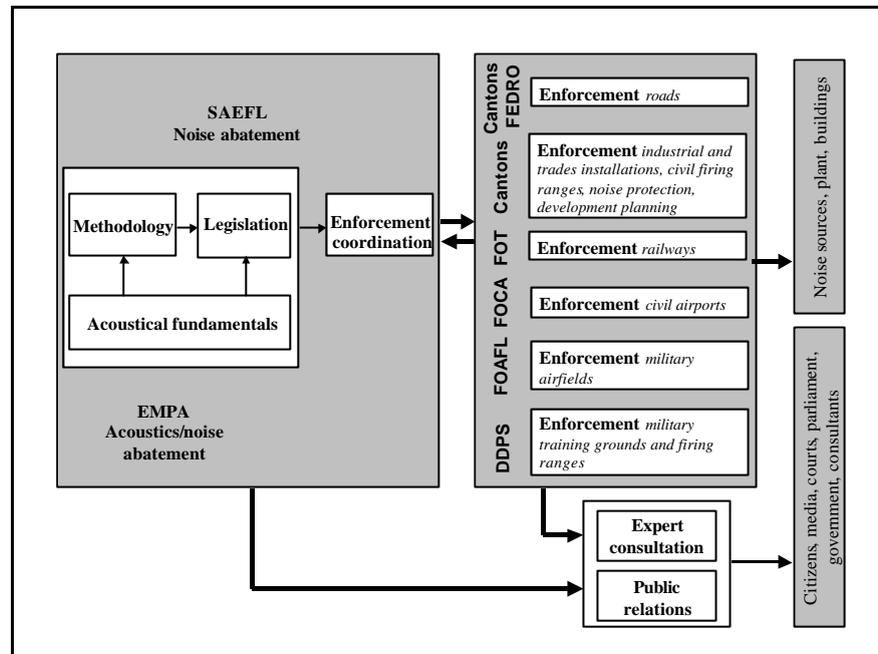


**Fig. 3.8**  
Breakdown of the specialised areas involved in noise abatement.

Intensive cooperation of the players from the various specialist areas is therefore of particular importance. In addition to purely scientific and technical areas, other areas such as legislative aspects, development planning, industry, landscape protection and protection of urban character, must be considered in connection with noise abatement.

The cooperation principle is also reflected in the decentralised organisation of noise abatement in Switzerland (Fig. 3.9). SAEFL is the professional agency of the Confederation in noise questions and manages the fundamental and strategic aspects of noise abatement. The actual enforcement is delegated to the individual authorities who are responsible for their own areas.

**Fig. 3.9**  
Division of noise abatement responsibilities among the players involved.



The cantons are responsible for enforcement where roads, civil firing ranges, industrial and trades installations, noise protection in buildings, and development planning are concerned. For noise protection measures on roads, SAEFL assesses eligibility for Federal subsidies in cooperation with the Swiss Federal Roads Office (FEDRO). The Federal Office for Civil Aviation (FOCA) and the Federal Office for Air Force Logistics (FOAFL) enforce noise protection for civil and military airfields, respectively. Railway enforcement is the responsibility of the Federal Office of Transport (FOT). All of the military training grounds and firing ranges are the responsibility of the Federal Department of Defence, Civil Protection and Sports (DDPS). Enforcement of the cooperation principle may also be seen in action in the relationship between the enforcement authorities and private persons. Here, the authorities do not simply order measures to be taken, but instead, the owners of installations must themselves submit an initial proposal for noise protection measures.

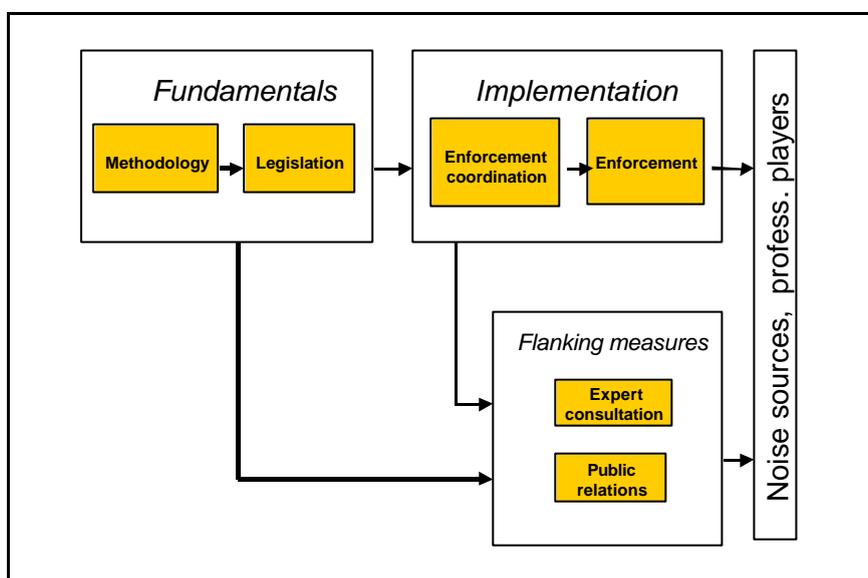
The Department of Acoustics/Noise Abatement at EMPA plays an important role. The Department is the scientific and technical centre within the Swiss Confederation for fundamental acoustic questions, and measurement and computational methods. The Federal Department of Home Affairs (DHA) and the Swiss Agency for the Environment, Forests and Landscape (SAEFL), though quite independent organisations, do complement one another at Federal level in fulfilling noise abatement tasks.

## 4 Current status of noise abatement

Noise abatement policy in Switzerland is oriented towards practical tasks based on current legislation. In this Chapter, the tasks, work status and projects in hand are discussed under the headings (Fig. 4.1):

- fundamentals
- implementation
- flanking measures.

The chapter concludes with a short review of noise abatement policy in the EU.



**Fig. 4.1**  
The principal categories in noise abatement policy.

The fundamentals include preparation of methodologies and legislation. Implementation comprises coordination and enforcement, while flanking measures cover professional consultation and public relations.

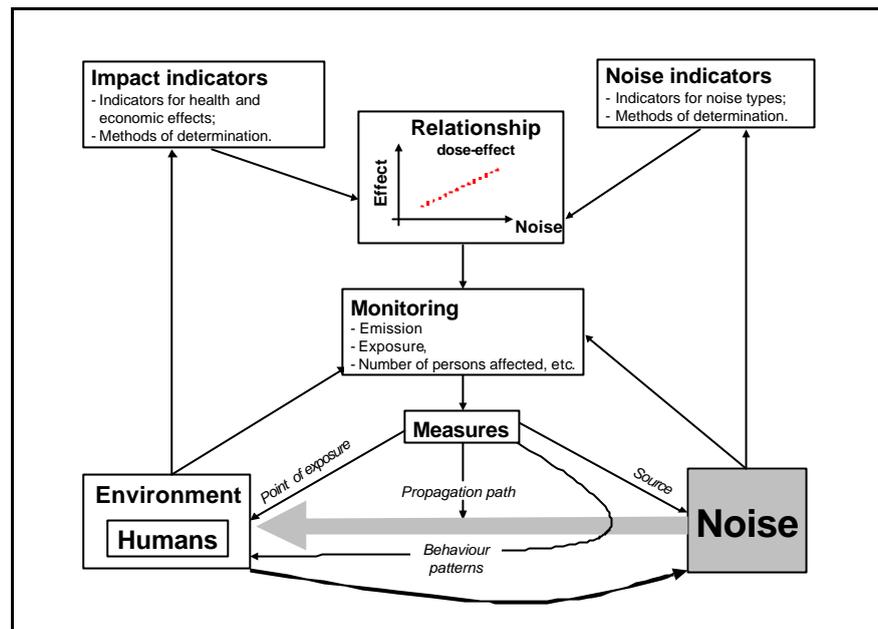
### 4.1 Fundamentals

#### 4.1.1 Tasks

The first step in noise abatement policy encompasses the development of a suitable methodology based on technical and scientific know-how developed in national and international research projects and based on practical experience. On this foundation, the implementation of tasks and objectives follows in legally binding form. This task is the responsibility of the legislator.

Fig. 4.2 shows a breakdown of the principal methodological aspects. The primary task is to establish indicators enabling noise exposure and its effects to be quantified. For practical reasons, the indicators should be clearly defined, simple and quick to determine, and suited to concise description of existing problems.

**Fig. 4.2**  
Diagrammatic representation of the methodology for establishing the fundamentals of noise abatement policy.



On the emission side, noise indicators must be established based on measurement or calculation. Required is a noise exposure indicator that mirrors the nuisance characteristics of the noise.

On the exposure side, impact indicators are sought to describe and quantify the psychological, health, social and economic consequences. These indicators are then combined to form a 'noise exposure indicator', enabling the dose-effect relationship to be specified in quantitative terms.

Monitoring is required to determine the order of magnitude and the extent of noise nuisance, and provide a basis for noise protection. For this, suitable methods and procedures must be developed.

Under measures, technical, operational and structural procedures must be prepared to reduce noise at source, either along the propagation path or – as *ultima ratio* – at the point of exposure. Included in these are development planning measures and measures intended to influence the behaviour patterns of those perpetrating the noise.

#### 4.1.2 Status

##### Noise indicators:

In Switzerland, the equivalent sound level,  $L_{eq}$ , which is averaged energetically and over time, is the customary sound indicator or noise exposure indicator. To obtain the rating sound level,  $L_r$  – a measure of the noise exposure (see Annex A) –  $L_{eq}$  is multiplied by a correction factor which accounts for the specific characteristics of the noise.

In Switzerland, time averaging is usually done over 16 day-time hours and 8 night-time hours.  $L_r$  has the advantage that it is relatively easy to determine and correlates well with impact for continuous noise sources. For short-period noise, either the averaging period is shortened (discos 1h) to better account for peak levels, or the maximum level (e.g. for rifle noise) used.

Lr is less suited for the assessment of effects where the impact depends more on the specific characteristics of the noise than on the sound level. An example of this is the noise from conversations, cowbells, church bells, etc.

The general noise level in a country represents a significant indicator for the sustainability of the economy. Although noise does not pollute natural resources (e.g. air and water), it detracts from the well-being of the population, and thereby exerts a negative influence on the health of the population. Till now, no sustainability indicators for noise have been defined in Switzerland. Also, there is no indicator for the assessment of total exposure (i.e. noise from several noise sources simultaneously), since the scientific basis for this is insufficiently conclusive.

For many types of noise (particularly for road noise, railway noise and airfield noise), noise exposure calculations are increasingly based on analytical models and traffic data (i.e. number and type of vehicle, aircraft, etc.). The reason for this is that measurements are expensive, time-consuming and hardly more precise. Calculations are of course essential for making forecasts. Measurements continue to be required for validating the calculations and for assessing the noise exposure in complex cases. EMPA is the main institution responsible for the development of models and algorithms for noise forecasts. EMPA disposes of the necessary scientific know-how and of the necessary independence.

For the calculations, suitable PC software is available on the market. However, the results may differ markedly depending on the analytical model and standards used, and on the particular contributory factors. A standard is presently in preparation in Germany on this question<sup>9</sup>. For road and railway noise, recommendations exist in Switzerland for suitable analytical models. However, these do not cover all the contributory factors (noise propagation, standards, etc.).

For noise emitted from the major Swiss airports, calculations are based on the FLULA2 model developed by EMPA. Further programs are in use in other countries, and international studies are now underway to assess their comparability.

For railways, noise exposure is calculated with the SEMIBEL program developed in the 1980s, and this is currently under scrutiny by an expert group with the participation of EMPA.

### **Impact indicators and dose-effect relationship:**

The health impact in the form of hearing defects (loss of hearing as indicator) caused by high noise levels is known. The protection measures can therefore be clearly defined (SUVA, SFOPH). For noise exposure levels below 80dB(A), this is more difficult, since these do not cause acute hearing defects. In the medium and long term, negative effects on health (under the WHO definition) resulting from the noise nuisance cannot be excluded. However, proof of a health deficit is hardly possible in particular cases. Persons who suffer frequent noise exposure are often also exposed to other forms of exposure, so that noise represents just one among many risk factors. Notwithstanding this, epidemiological studies have clearly demonstrated the negative effect of noise on health. Thus the risk of cardiovascular and other complaints increases with increasing noise exposure. Also, sleep disturbance and a marked performance deficit in cognitive processes have been demonstrated. To assess the extent of sleep disturbance due to noise, the probability of waking reactions is used, among others, as indicator. Other assessment methods are also used, in which the hormone changes in the body under the influence of noise are measured, both while awake and asleep. Owing to the

large variety of noise effects on human beings, a comprehensive treatment of impact indicators cannot be given here.

A frequently used indicator for the noise exposure of the population is the percentage of significantly affected persons based on socio-psychological surveys (see Annex A). In Switzerland, the exposure limits are specified separately for the different noise categories based on the dose-effect relationship. The impact threshold is set at the point where 15 to 25% of those questioned are significantly disturbed (see Annex A). Till now, noise impact thresholds have been defined for roads, railways, civil airfields, civil firing ranges, industrial and trades installations, and military airfields.

The indicator for the economic impact of noise is based mainly on the costs incurred. The necessary methodology for determining the costs resulting from noise is, however, incomplete. Although the costs incurred for noise abatement measures are known, those for the so-called external costs may only be estimated. Efforts to develop models for assessing the costs of noise are concentrated at present on the depreciation of real estate<sup>5</sup>. The costs of medical treatment resulting from noise exposure of the population are not yet generally included. Also, noise costs are not yet included in life-cycle assessments, although suitable methods are now available for this<sup>19</sup>.

The social impact of noise is mainly associated with urban changes (expansion of slum areas and formation of ghettos in noisy areas)<sup>1</sup>. No indicator has yet been defined for these effects.

#### **Monitoring:**

Noise monitoring in Switzerland is concentrated mainly on exposure. Noise exposure registers have been prepared for roads, railways, airfields and (partly) for civil firing ranges, in which the noise exposure of those living in areas affected by noise is recorded. The noise exposure registers mainly serve remediation purposes, i.e. data acquisition is restricted to cases in which the limit values are exceeded, and to a rough estimate of the number of persons affected.

In Switzerland, noise exposure registers are usually prepared based on measurement, and recorded cartographically (i.e. in paper form). These document the exposure values, and as a rule are only updated when remediation is carried out. Increasingly, however, analytical models and electronic storage systems are being introduced. For these, calculated noise exposure is coupled with the land use and demographic data (for residential areas) by means of geographical information systems (GIS). In the interests of simple and efficient monitoring, it is intended in future to prepare all noise registers on this basis. For those noise categories not mentioned above, comprehensive noise registers are not available. This is particularly the case for industrial and trades installations, although for these, noise exposure is recorded on a planned basis if there is cause to believe that the limit values are being exceeded, or in case of complaints.

Monitoring must at present be performed separately for each noise category, since owing to lack of scientific knowledge, a noise indicator for assessing total noise exposure is not at present available.

A further form of monitoring consists of regular representative surveys of the population on the noise question. Surveys of this kind on the extent of, and disturbance resulting from, noise are a relatively inexpensive instrument for the provision of data on the noise situation.

**Measures:**

The basis for technical, operational, structural and development planning measures for the avoidance, reduction and protection of the population from noise is relatively well advanced. (see Annex A for a breakdown of the effects of individual measures). Research work is continuing in all areas, particularly at EMPA, where well-equipped laboratories are available for the determination of the noise protection properties of materials and building elements. Alternative measures such as economic instruments (incentives for reducing noise emission at source) are still not applied to any great degree.

In the development of methods for noise abatement, it is extremely important to concentrate work on the source, since this is of benefit in all areas. Efforts to establish emission limits for appliances, vehicles and aircraft must be continued. In Switzerland, this area is covered by legislation within the EU and by the International Civil Aviation Organisation (ICAO), so that there is little leeway for national regulations.

**Legislation:**

The objectives and principles of noise protection are laid down in the LPE and NAO. Exposure limits have been defined for the principal noise sources such as roads (Annex 3 NAO), railways (Annex 4 LPE), civil airports (Annex 5 LPE), industrial and trades installations (Annex 6 LPE), civil firing ranges (Annex 7 LPE) and military airfields (Annex 8 LPE). For military firing ranges and training grounds, no exposure limits have been defined in the NAO. There is, however, a guideline on the assessment and reduction of noise from these, and this is enforced by the DDPS.

For the noise from building sites, the NAO concept of exposure limits cannot be applied, since sound from these sources (beating, hammering, etc.) is too complex, and is extremely intermittent. The guideline for the reduction of noise at building sites is therefore based on preventive emission reduction through operational and technical measures.

Vehicle type approval is based on EU legislation. For this, the Federal Law relating to Technical Barriers to Trade ('Bundesgesetz über die technischen Handelshemmnisse') was harmonised with EU regulations.

### 4.1.3 Future projects

For noise indicators, the criteria for the assessment of specific noise categories (i.e. sudden noise in quiet surroundings, noise from sporting events, animal noise, behavioural noise) are to be specified. It is also intended to define sustainability indicators and an indicator for total noise exposure. In the determination of noise indicators, regulations for ensuring the consistency and comprehensibility of the computer calculations – particularly for roads, railways and airfields – are planned.

The number of impact indicators must be extended to all forms of health impairment (sleep disturbance, long-term bodily symptoms, etc.), and to the economic and social ramifications (external costs, influence on residential areas).

It is planned to establish a monitoring procedure to cover the whole of Switzerland, thereby enabling the indicators for emission, exposure and other noise-related data (population affected, type of utilisation, etc.) to be recorded in a noise information system.

Noise protection measures will concentrate on the source (emission limits for appliances, vehicles and aircraft). SAEFL is the specialist government agency for noise and is preparing to represent Switzerland in the relevant international committees. Over and above this, economic incentives for noise reduction are to be evaluated.

Concerning legislation, work is currently in progress on the Ordinance relating to Type Approval and Labelling of Noise Emission from Appliances such as Lawnmowers and Building Machinery ('Verordnung zur Typenprüfung und Kennzeichnung der Lärmemissionen von Geräten wie Rasenmähern und Baumaschinen') and establishment of remediation standards (emission limits) for railway rolling stock. Annex 7 of NAO (exposure limits for civil firing ranges) is being extended to include assessment criteria for sports weapons and exposure limits for military firing ranges and training grounds.

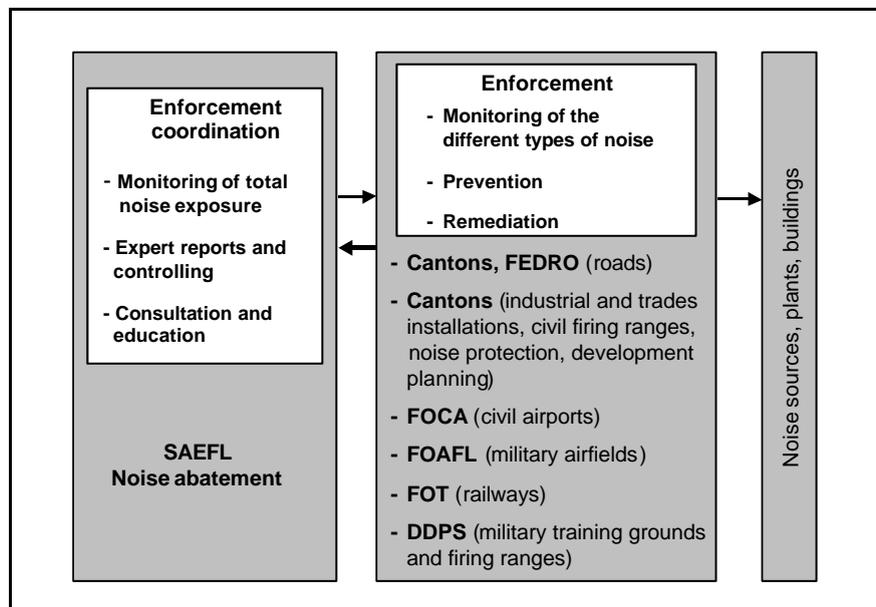
The SIA 181 standard<sup>22</sup> on noise protection in buildings is being revised.

## 4.2 Implementation

### 4.2.1 Tasks

Noise abatement policy is implemented in Switzerland in compliance with its federalist structure by the environmental protection agencies of the cantons (26 in total) and the Federal agencies concerned (Fig. 4.3). The coordination tasks are delegated to the specialist Federal agency for the environment (SAEFL) in order to ensure consistent enforcement and provide support to the remaining enforcement authorities.

**Fig. 4.3**  
Implementation of noise abatement policy by the cantonal and Federal agencies.



The enforcement procedures are laid down in legislation and consist of monitoring the individual noise categories and of implementing the prevention and remediation principles. Enforcement coordination comprises consultation and training of the enforcement authorities in legal and technical matters. It also involves advice on remediation projects and controlling of road

noise remediation projects for which Federal subsidies have been provided. Finally, it includes nation-wide monitoring of noise exposure based on the separate monitorings of the various enforcement authorities.

#### 4.2.2 Current status

##### Monitoring

Noise exposure monitoring in Switzerland is heavily concentrated on the remediation of installations. Noise exposure measurements are therefore limited to locations where the limit values are expected to be exceeded, requiring noise remediation for the protection of the population in the areas affected. Since, however, the limit values depend on the uses to which the areas are put, and although the number of residents affected by noise exceeding the limit values may be estimated, more precise data on the extent of noise exposure of the population are not usually available.

Estimates in 1985 show that before the NAO entered into force about one-quarter of the population was subject to road noise above 60dB(A). The limit value quoted applies to residential areas in sensitivity level II. In absolute terms, some 1.6 million persons were affected. However, it may be estimated from the cantonal noise exposure registers that only about 550 000 persons would be entitled to profit from noise remediation under current legislation (LPE and NAO). The marked discrepancy of over one million persons between the two above-mentioned figures may partly be explained by the fact that many large noise-exposed areas are classified under sensitivity level III (mixed zones), for which the limit value is 65dB. Also, the authorities may relax the requirements for public roads where remediation is considered to be economically unacceptable. Although in this case noise protection windows must be provided for the buildings affected where the alarm value of 70dB is exceeded, the restrictions contained in the NAO result in two-thirds of those affected not being entitled to noise remediation measures. This circumstance is not restricted to road noise, but applies equally to the noise from railways and airfields. According to the noise exposure registers, over 2600 km of roads are in need of remediation. Of these, 290 km are motorways, 390 km national highways and some 2000 km other roads.

For the railway network, 270 km of noise barriers are required. These in combination with noise reduction of rolling stock and noise protection windows should provide protection to some 265 000 persons subject to exposure above the impact thresholds.

Noise exposure registers have been prepared for most of the civil airfields (an exception is Zurich airport in Kloten, for which the revised register will depend significantly on the governmental agreement between Switzerland and Germany). It is estimated that over 100 000 persons are subject to noise from civil airports above the impact threshold.

The noise exposure resulting from most of the civil firing ranges (totalling some 2000 installations) has been recorded in sound exposure registers, and a small number by means of spot checks. SAEFL has prepared special software programs to calculate noise exposure resulting from weapons used at civil firing ranges. Prior to remediation, the number of persons subject to noise exceeding the impact thresholds was approximately 75 000.

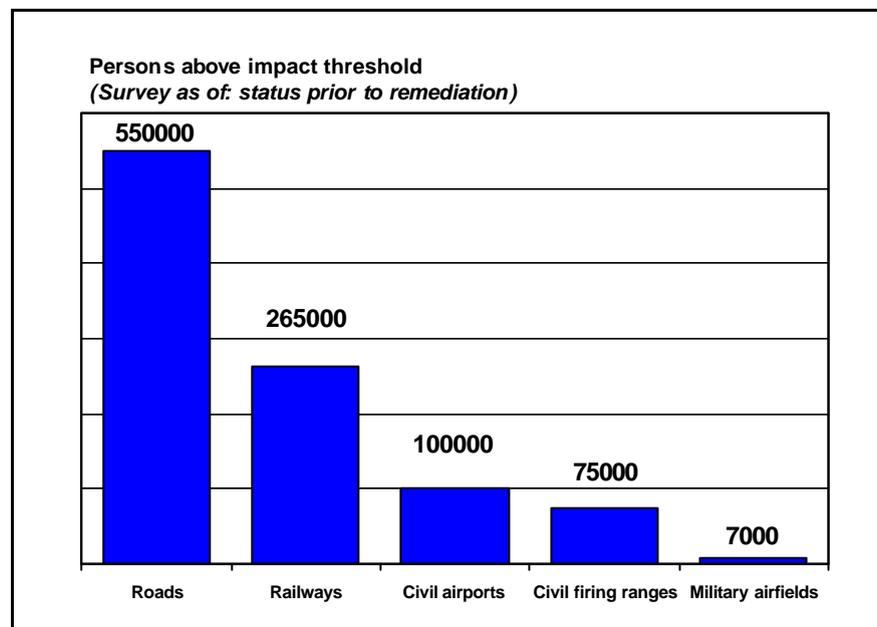
Noise exposure registers are available for all twelve military airfields. The number of persons subject to noise exceeding the impact thresholds is estimated at over 7000. Although the

noise from military flights (including those from jet fighters) is higher than that from civil flights, this generally proves to be less problematical than noise from civil flights in the vicinity of the national airports in Zurich and Geneva. The reason for this is that military flights are restricted to working hours, so that during mid-day, the evening hours and at the weekend, it is mainly quiet. However, the increasing use of military airfields by private aircraft presents a problem.

There is no full monitoring programme for industrial and trades installations, and no noise exposure registers are prepared for these. Exposure is nevertheless recorded in noise maps if there is reason to believe that the limit values are being exceeded, or in cases of complaint. To judge by the responses of the specialist cantonal agencies contacted, the problem appears to be relatively limited, since the noise from these installations has already declined significantly thanks to existing SUVA regulations on noise limitation at the workplace.

The number of persons subject to noise above the impact thresholds for the five principal noise categories is summarised in Fig. 4.4.

**Fig. 4.4**  
Estimates of the number of persons subject to noise above the impact thresholds (prior to remediation).

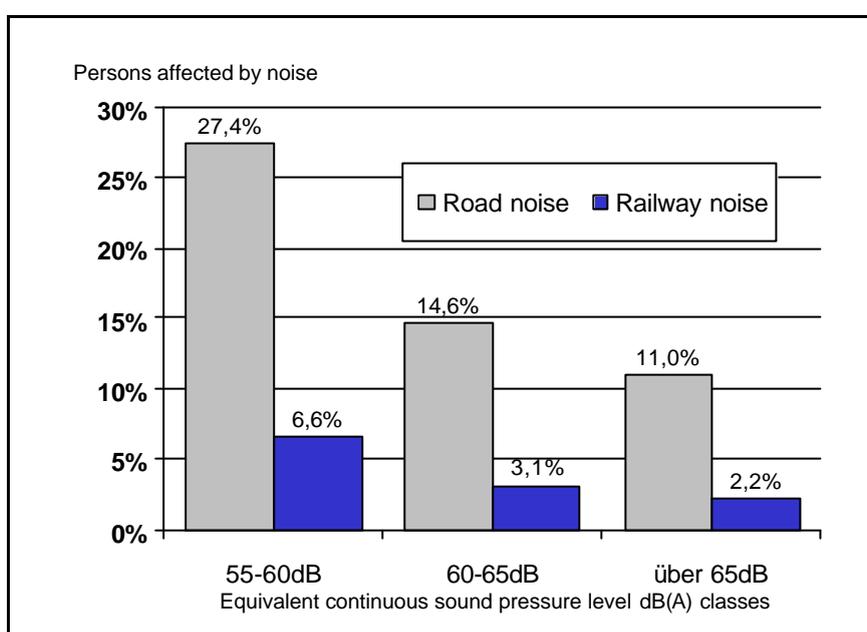


The noise exposure due to military firing ranges and training grounds has not yet been compiled in registers, since the necessary exposure limits are not available. These installations, numbering about 70, cause only modest exposure, since firstly they lie outside residential areas, and secondly generate noise only over limited periods.

Noise categories other than those mentioned above are not systematically recorded in Switzerland. This is due to lack of a scientific basis for generally assessing the noise from conversation, music, household appliances, etc. by means of exposure limits. For these noise categories, the noise nuisance depends more on the particular situation and on the attitudes of those affected than on acoustic intensity. Methods for assessing the noise nuisance other than by exposure limits, although available, are still insufficiently reliable. In these cases, therefore, the noise impact must be studied on a case-to-case basis.

For a holistic assessment of noise exposure, both the number of persons affected by noise exceeding the limit values and of those exposed to lower levels of noise are of interest. The latter values are also required for international comparisons. An ongoing assessment of social attitudes to the noise question is also important, as this enables an assessment to be made of how the noise problem is regarded in the public mind, and permits changes in public attitudes to be identified.

In Switzerland, the numbers of persons subject to particular levels of noise are not available from monitored data, so that here, estimates based on analytical models must be employed. The most recent analytical calculations for the principal noise sources (roads and railways) were carried out before the NAO came into force (Fig. 4.5).



**Fig. 4.5**

Percentage of the Swiss population affected by road and railway noise (data taken before the NAO entered into force in 1985).

The results show that more than 50% of the population was subject to road noise above the critical limit of 55dB(A) during day-time<sup>26</sup>. For railway noise, the figure was just over 10% of the population. WHO quotes a guide value for noise exposure outside of dwellings of 55dB(A) over a period of 16 hours. Exposure values above this level generally cause significant disturbance.

According to a survey<sup>17</sup> on subjective attitudes to noise, some 64% of the Swiss population feel disturbed by noise. Even though specific details on the duration and intensity of noise exposure could not be given by the persons interviewed, this represents a valid statement on the general state of well-being of the population.

Also, although the 1998 survey is not directly comparable to the estimates made in 1985, it clearly indicates that noise exposure has not declined in the meantime. Since noise exposure has not till now been accurately monitored, no comprehensive or exact data are available. However, from the discussion below it is clear that the noise situation has tended to worsen.

A significant indicator of the suspected increase in noise exposure is the heavy increase in traffic. Because of the logarithmic relationship between kilometres driven and noise exposure,

noise exposure is slowly but steadily increasing. As far as passenger transport in Switzerland is concerned, the increase in vehicle kilometres<sup>2</sup> on the roads between 1985 and 1995 was 20%, on the railways 14% and in the air 70%.

Measurements of traffic volume on national highways show that the increase in traffic is not spread uniformly over the entire road network, but is mainly concentrated on the main transport routes, exacerbating the problem of noise there. It is often argued that the steady lowering of the emission limits for vehicles in recent years has led to a reduction in noise exposure. A look at the development of the EU emission limits for road vehicles shows that between 1988 and 1996 the emission limits were tightened<sup>11</sup> (for cars from 77 to 74 dB(A), busses from 80 to 78 dB(A), and lorries from 84 to 80 dB(A)).

In this, it should be noted that type approval for motor vehicles does not correspond to real operating conditions. For one, motor noise is measured at a constant test speed of below 50 km/h, whereas tyre noise at higher speeds is the dominating factor. Also, owing to the 'sporty' and louder mode of driving encouraged by more powerful engines, and the tendency towards broader tyres and heavy cars, tyre noise is on the increase. As a result, the vehicles in daily use have become louder despite falling emission limits. This conclusion is confirmed by measurements at EMPA. To account for this, the emission level calculated using the Swiss model for road noise would have to be increased by 1dB. It must therefore be concluded that for road noise, the in-service vehicle fleet, coupled with the increase in traffic, leads to a significant increase in the noise exposure of the population. The situation is abetted by the increase in goods traffic. Goods traffic accounts for a higher share of road noise than its numbers would suggest, the noise from a lorry being equivalent to that of 10 cars.

For railway vehicles, no emission limits are specified, and no type approval is required. However, the latest generation of passenger trains fitted with disc brakes are much quieter than older vehicles with block brakes in cast iron. Notwithstanding, the main noise contribution still comes from goods wagons fitted with block brakes. Taken as a whole, therefore, there has been an increase in the noise emitted by railway vehicles.

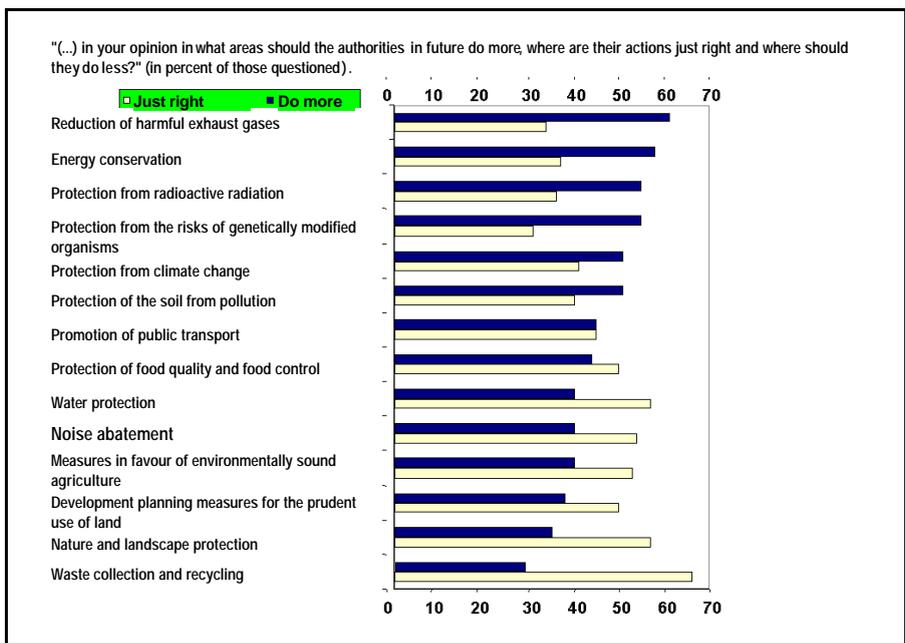
With air traffic, there is also a clear trend towards quieter aircraft. However, technical advances are generally insufficient to compensate for the additional noise from increased traffic volume. Also, this is partly due to the fact that the additional traffic is mainly concentrated at the major airports. This is well illustrated by the current problems at Zurich airport, and these are expected to worsen in the middle term.

With the exception of the railways, which are now remediating their rolling stock, traffic noise will continue to increase. Here, road noise will remain the dominating cause of noise exposure in Switzerland. Taken together, noise exposure of residential areas and the countryside will continue to increase. Private aircraft and helicopters contribute significantly to this effect owing both to the emission profile of the sound emitted, their mobility and their low altitude. Further, plans to authorise ultra-light aircraft (so-called eco-light aircraft), for which a less stringent pilot license may be obtained, and which are inexpensive to fly, will deepen the problem in the middle term.

It cannot be denied that the increasing exposure to noise in Switzerland is related to the movement towards a 'recreational' society. Also, many recreational activities occur during the

night. The quieter nights are under increasing pressure through more flexible working hours and the changing structure of goods supply.

A representative survey<sup>14</sup> was carried out in 1999 (Fig. 4.6) on the relative importance attached by the public to noise abatement in comparison to other environmental issues. The survey shows that in the popular mind, only those environmental factors and risks that lead to a *direct* threat to life and health are significant. The perceived need for action is correspondingly low. In other words, the public attaches only modest importance to the noise problem. However, it is interesting to note that some 40% of those questioned favour improved noise protection.

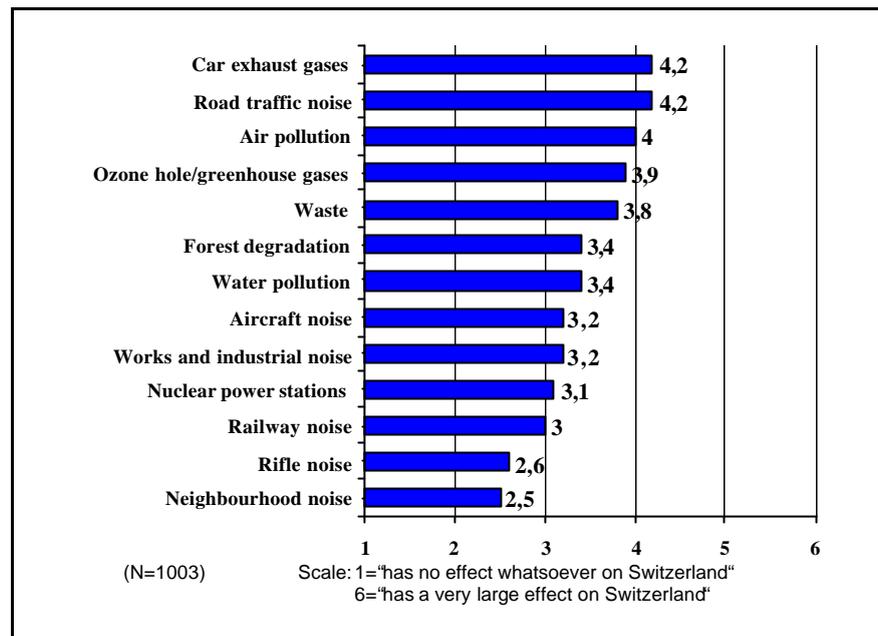


**Fig. 4.6**  
Importance of noise abatement in comparison to other environmental issues<sup>14</sup>.

The representative survey carried out by Lorenz<sup>17</sup> in Switzerland provided a more detailed picture of the significance of the various types of noise (Fig. 4.7). According to the study, road traffic noise is subjectively regarded as the greatest problem among the various sources of noise. This corresponds to the objective need for noise remediation. The fact that aircraft noise figures in *second place* among the various types of noise is presumably due to current public interest in the problem of noise in the vicinity of the national airports.

It is also interesting to note that the negative effects of road transport in Switzerland are regarded as equally grave as that of exhaust gases. Those questioned regard the noise problem of roads as even more serious than that of air pollution.

**Fig. 4.7**  
Relative importance of the noise problem compared to other environmental themes classified according to noise type.

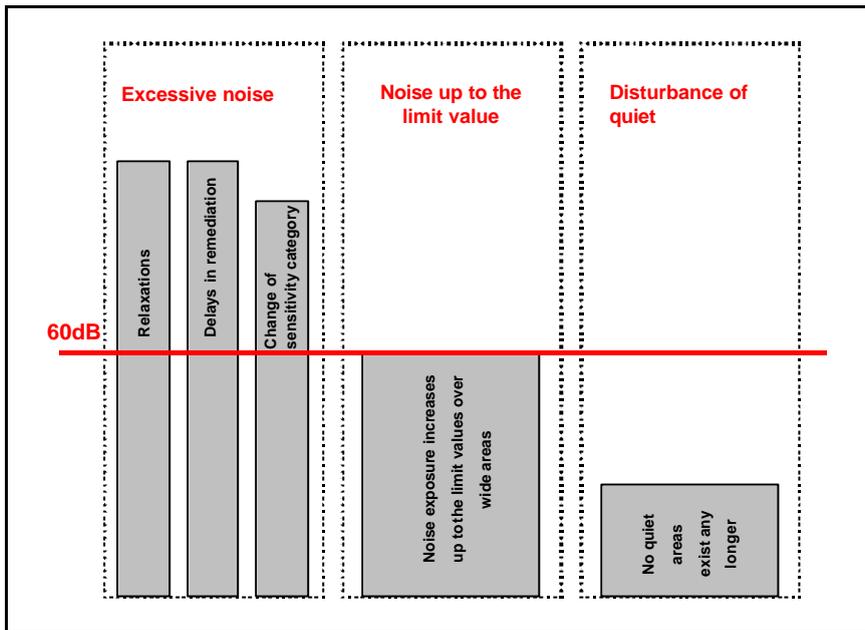


From a global perspective, three fundamental aspects of noise exposure may be identified (Fig. 4.8):

Firstly, there exist areas in the vicinity of transportation facilities with *clearly excessive noise*. Here, the noise exposure lies above the limit value specified for residential zones. This is due on the one hand to legislative relaxations permitted for public and concessioned installations. On the other hand, delays in remediation mean that roads and railways cannot be remediated by the completion time originally planned in 2002. A further reason is the assignment of mixed zones to sensitivity category III, despite the fact that the population living in these is equally sensitive to noise as that in purely residential zones with sensitivity category II.

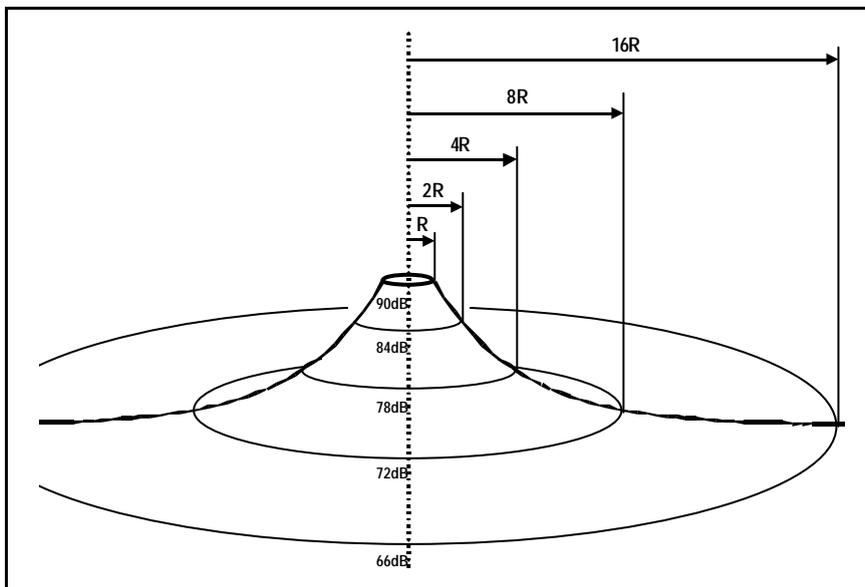
Secondly, in residential areas there is a general tendency for the *noise exposure to approach the impact thresholds at all places*, and for very little to be done to counteract this. Although, of course, the objective of setting the planning values below the impact thresholds is to keep the total exposure caused by several installations below the impact thresholds, the total emission from four installations having the same emission level would be 6dB higher than for a single installation. Here, too, the restrictions may be relaxed if compliance with the planning values would lead to an unacceptable burden to the operator of the installation.

Also, although the preventive principle obligates the owner to reduce noise below the planning values if this is technically and operationally feasible and economically acceptable, this provision is seldom applied, and it is generally regarded as sufficient to comply with the planning values.



**Fig. 4.8**  
 Three distinct noise exposure situations in Switzerland. The 60dB line represents the impact threshold for residential areas (sensitivity category II).

Thirdly, there is increasing *insidious noise exposure* of formerly *quiet areas*, particularly of those in the countryside, open recreation areas and areas of natural beauty. Noise emission partly occurs directly in these areas as a result of the changing recreation patterns of the public. However, it mainly arises from the 'classical' sources of noise such as roads, railways and aircraft, which affect them in the form of increased background noise level. Aviation in particular (see example of a point source in Fig. 4.9) can inundate extensive areas in a flood of noise owing to the almost unhindered spreading of noise.



**Fig. 4.9**  
 The 'noise cone' illustrates the influence of noise over large areas caused by a point source, e.g. hovering helicopter. To reduce the noise level by 6dB, the distance must be doubled.

The protection against excessive noise provided for in legislation does not include a 'right to quiet'. This leads to an increase of relatively low-level noise exposure, which, however, is sufficient to detract from the value of a recreational area. This is due not only to the increase in sound level, but also to the spatial and temporal expansion of noise exposure. Thus the principle of setting limit values is inadequate to combat the problem.

Taken together, all these developments point to an increasing noise detriment to our living space, against which existing legislation is powerless to act.

### **Status**

Switzerland has introduced obligatory type approval procedures for new vehicles to limit noise emission. The provisions were either taken directly from EU legislation, or are otherwise fully compatible with it. International provisions on aircraft emission have also been adopted. For aircraft, the provisions of the ICAO apply, in which Switzerland is represented by the Federal Office for Civil Aviation. No ordinance is yet available for type approval and labelling of appliances (lawnmowers, building machinery, etc.). Owing to its international involvement, particularly with the EU, Switzerland has only limited scope for manoeuvre in the field of approval regulations for vehicles, aircraft and appliances.

In implementing the preventive principle in development planning, a conflict exists between the needs of noise protection and the economic interests both of the owners of installations and of property. In consequence, preventive noise protection meets with vigorous opposition.

Particularly in the case of new buildings and extensions of public and concessioned installations, the interests of noise protection are usually on a weaker footing than those of economics. A good example of this is Phase 5 of the extension project at Zurich airport involving additional noise far in excess of the limit values, for which no changes in the project were required. As a result, the scope for development planning in the communes is significantly curtailed.

In allocating land for new buildings, strong resistance to implementing preventive measures is often felt, since building land is scarce. Should excessive noise exposure prevent development of an area, this can lead to major financial loss and restricted freedom of residential development for the commune affected. This is particularly the case for airports, since there, structural and/or operational emission reductions are hardly possible, resulting in an effective ban on residential building in extensive areas around airports.

For new buildings with rooms sensitive to noise, the final prevention phase must be activated, i.e. the use of high-insulation external building elements and internal partitions. This type of prevention should prove simple to enforce, since (a) there is little conflict potential involved, (b) the costs of effective sound insulation represent only a modest proportion of total building costs, and (c) the latter measures result in appreciable benefit. The Swiss standard for noise protection<sup>22</sup> is currently being amended.

### **Remediation**

By far the greatest need for noise remediation concerns the roads. The total cost of remediation amounts to some 3.4 billion Swiss francs. Till now, some 1.2 billion Swiss francs have been expended, representing approximately one-third of total remediation costs. The completion date of 2002 originally planned is expected to be extended by several years. This applies particularly to urban roads, for which Federal remediation subsidies are lower than for the motorways, and to the Federal highways. There is also a need for additional measures to accelerate road noise remediation. The principal reasons for the delays are the high costs, the difficult financial position of many cantons and the lack of a national noise abatement lobby.

Also, railway noise remediation is far behind schedule, mainly for financial reasons. The situation has now eased following acceptance by the electorate of the 'FinöV' proposals for financing public transport. As soon as the necessary legislation has been adopted and the financial

expenditure approved by parliament, the remediation work can commence. It is planned to remediate all rolling stock by 2009 and to complete structural measures along the railway routes by 2015. The total costs of noise remediation amount to 1.2 billion Swiss francs. This does not include the rolling stock of foreign railway companies using the Swiss network. The goods wagons concerned represent over 75% of transit traffic through Switzerland<sup>15</sup> and therefore contribute significantly to railway noise exposure.

Remediation of the regional civil airfields with airline transport has been in progress for a considerable time, owing to the fact that for these, limit values were introduced when the NAO entered into force. Exposure limits for the national airports in Basel, Geneva and Zurich were not then specified. With the specification of limit values for all of the civil airfields in June 2001, remediation work at the major airports can now begin. In practice, this concerns purely noise protection measures on existing buildings, since the technical possibilities have been largely exhausted and operational restrictions are hardly enforceable. Prior to this, however, the noise exposure registers must be prepared for the national airports. In the NAO, the remediation work must be completed by 2016 at the latest, but according to airport regulations, part of the work must be completed considerably sooner. Estimates place the costs of this work at around 300 million Swiss francs based on the operating figures for 1997.

For industrial and trades plant, most of the remediation work has been completed. It is anticipated that all plant will have been remediated by the completion date in 2002.

Remediation of civil firing ranges is making good progress but is not equally well advanced in all cantons. The anticipated costs for structural remediation measures lie in the range of 90 million Swiss francs. It is not intended to extend the remediation deadline.

For military airfields, the remediation programme has commenced and should be completed by 2010. As for civil airfields, remediation consists principally of noise protection measures on buildings. The estimated costs of noise remediation amount to some 24 million Swiss francs, whereby preparation of the noise abatement register will cost 1.5 million Swiss francs. Due to increasing civil use of military airfields, the danger exists of an increase in noise exposure, and this could lead to an additional need for remediation.

The absence of exposure limits for military firing ranges and training grounds has not inhibited essential remediation work, since the regulations already issued embody the main assessment principles. However, the work cannot be completed until suitable exposure limits are specified in the NAO. The noise problem here is of relatively minor importance for the country as a whole. The remediation costs are expected to be comparatively low, due to the fact that noise protection can mainly be achieved by means of operational measures (e.g. time restrictions and use of simulators).

Remediation of a noise problem as specified in the LPE is only possible if the noise nuisance can be attributed to an installation. Thus in the case of loud voices and music from private apartments, and the slamming of car doors in the neighbourhood, noise abatement can only be enforced based on neighbourhood or municipal law. If, however, noise of this category occurs in connection with the operation of an installation (e.g. restaurant), this is taken as noise arising from an installation and is covered by LPE and NAO.

### **Coordination and controlling**

The authorities responsible for enforcement (Federal agencies and cantons) must make regular reports to SAEFL on progress made in noise remediation. Coordination on the part of SAEFL is of a strategic and conceptual nature and has the objective of ensuring consistent enforcement of the NAO in the whole of Switzerland, thereby ensuring a 'unité de doctrine'.

Without special authorisation, SAEFL cannot act to accelerate the enforcement procedure or to intervene in case of dissidence. The specialist Federal environmental agency is only consulted when complaints are filed with the Federal Court. However, certain control activities are possible in the case of road noise remediation. Here, the Confederation assesses the entitlement to subsidies from mineral oil tax revenues when reviewing the remediation programmes prepared by the cantons. While SAEFL is responsible for assessing the acoustic aspects and the commensurability of the measures, FEDRO is responsible for questions of road construction, transport technology and safety. However, since the Confederation can only review the cantonal projects, is not possible for it to accelerate the enforcement process. The plans for a 'New Financial Settlement' ('Neuer Finanzausgleich') will have an influence on this, since it is intended that lump-sum payments be made to the cantons out of revenue from the mineral oil tax.

### **Consultation and training of the enforcement authorities**

In connection with the introduction of the LPE and the NAO, the Confederation intensively pursues professional training to ensure that both the cantonal and communal authorities, and private industry, have access to suitable specialists. However, now that remediation work has begun, this activity is no longer regarded as urgent and has been somewhat downgraded. Owing to a scarcity of personnel in the Confederation, professional training has been increasingly pursued in cooperation with the cantonal enforcement specialists (i.e. 'Cercle Bruit') and the Swiss Acoustical Society (SGA). It is now 15 years since the NAO entered into force, and many of the older experts in the specialist cantonal noise protection agencies will soon be coming up for retirement. These must be replaced by younger people. The Confederation must therefore take renewed action in the training field.

## **4.2.3 Future projects**

Noise monitoring (also see Chap. 4.2.2) will enable improved procedures to be introduced for the preparation of detailed emission and exposure maps, and their regular updating. Also, a more thorough procedure is planned to assess the quantitative and qualitative effects on the public than was hitherto possible on the basis of impact thresholds.

In the prevention field, the regulations concerning type approval of mobile appliances and railway wagons are to be finalised. Currently, SIA standard no. 181 is being revised to accord with latest noise protection technology. For the noise remediation of roads, acceleration measures are to be prepared to enable remediation to be completed within the extended periods. Proposals for this are contained in a research paper<sup>21</sup>. In addition, railway remediation plans must be implemented, and the set completion dates complied with. Concerning coordination and controlling, implementation of the 'New Financial Settlement' must be carefully considered to ensure the parity of enforcement in all cantons.

For the future, training of cantonal enforcement specialists must be backed up by providing an adequate programme of training courses.

## 4.3 Flanking measures

### 4.3.1 Tasks

Flanking measures include the provision of a specialist consultation service. As opposed to the field of public relations, this concerns the preparation of expertises on scientific, technical, development planning and legislative themes in the field of noise abatement. Specialist consultation is directed mainly to the authorities, courts and private consultants, but is also open to others.

Public relations also belongs in this field. The task of public relations is to inform and sensibilise the wider public to the noise question, by direct contacts, publications and talks at meetings.

### 4.3.2 Current status

SAEFL is the specialist agency responsible and answers over 500 enquiries on noise per year. These concern cases filed with the Federal Court, life-cycle assessments, approval procedures for drawings, professional questions on noise protection and development planning, parliamentary motions and international enquiries. In addition to the specialist cantonal agencies, which are responsible for these tasks at cantonal and communal level, Switzerland disposes of a relatively dense network of specialist agencies. Also, Federal and cantonal specialists frequently speak at national and international specialist meetings and congresses.

Consultation services on purely acoustic and measurement problems are provided both by private consultants and by the Department of Acoustics/Noise Abatement at EMPA. EMPA has the advantage of being able to cover both consultation services and basic research. It therefore provides a significantly broader range of services than the private sector.

A specialist consulting service must of course be able to draw on suitable experts. In Switzerland, only relatively modest provision is made for education and training in noise and acoustics, and none of the advanced education colleges has a chair for acoustics. Moreover, efforts began in 1999 to transfer the specialist centre for noise abatement at EMPA to another organisation. This would be tantamount to closing this faculty, and would seriously weaken the existing consultation and training services in noise abatement.

The task of public relations is principally to inform and advise the media and the public on noise questions. In addition to popular brochures, printed information, information sheets and talks at events and meetings, the Internet is playing an increasingly important role.

Despite the magnitude and universal nature of the noise problem, there is little public discussion of this theme in comparison to other environmental concerns. There is therefore a clear need for action to heighten public awareness of the need for lowering noise exposure and assuring greater quiet.

### 4.3.3 Future projects

At present, the SAEFL website is being extended to enable consultation services to be provided via this medium. It is also planned to couple this service with that of the cantons (involving cooperation with 'Cercle Bruit').

It is also planned to introduce training services for noise abatement at advanced level (universities, ETH, advanced colleges of education).

In public relations, popular brochures on noise and the safeguarding of quiet are planned to increase public awareness of this environmental issue.

## 4.4 Noise abatement in the EU

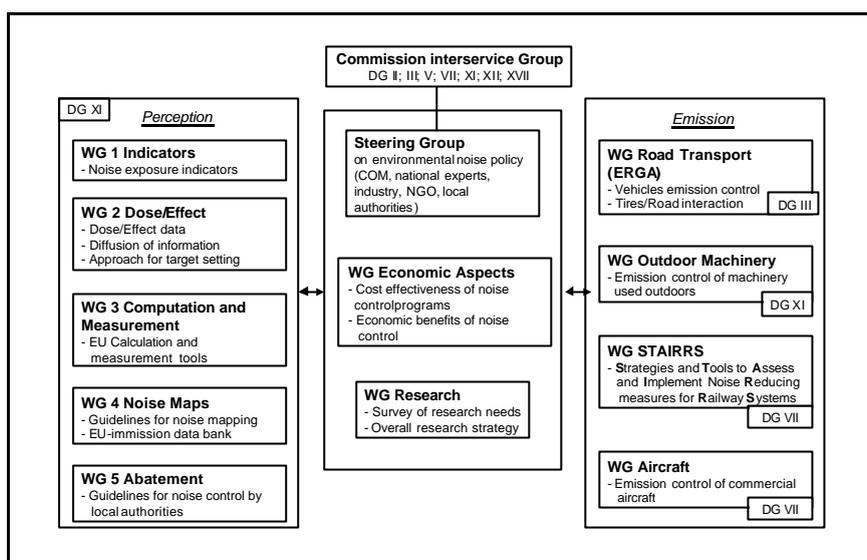
### 4.4.1 The beginnings

In the EEC agreement of 1957, no mention was made of the environment. Not until 1972 did the former European Community adopt its first environmental action programme, in which, among other things, the prevention and polluter pays principle was accorded the status of a fundamental maxim. In the third environmental action programme (1982 to 1986), the safeguarding of human health figures as a central objective. Also, the increasing introduction of environmental policies in the transport sector is proposed. However, proposals of this nature are not legally binding. In 1990, it was resolved to found the European Environmental Agency. In 1991, the Community extended its involvement in environmental issues by founding the EU (Maastricht agreement).

The environmental policies of the European Community are directed primarily towards strengthening the markets within the Community by virtue of common regulations for emission limitation. Likewise, the principle of regulations on noise protection coordinated among member states is applied to avoid barriers to the free exchange of goods within Europe.

In the past, the decision-making process has repeatedly proved to be difficult. Despite the decision taken on 1.1.1993 that decisions by the Council of Ministers in environmental questions no longer have to be passed unanimously, but require only a qualified majority, proposals by the most progressive countries to introduce higher standards were rejected. Thus for legislation and standards, the principle of the least common denominator continues to be applied. The standard framework for legislation is the guideline in conjunction with binding objectives. The choice of ways and means of implementation remains with the national authorities. Guidelines must be carried over into national law within two years. A list of EU guidelines in the noise sector is given in Annex B.

In its fundamental 'Future Noise Protection Policy (1996)' Green Book<sup>11</sup>, the EU Commission outlined its future noise protection policy. As a result, specialist working groups (WG) were established (see Fig. 4.10). The programme was officially inaugurated at the 'Future Noise Policy in the EU' conference in Copenhagen (September 1998). The programme, whose objective is to unify noise abatement policy, is to be concluded in autumn 2002.



**Fig. 4.10**  
Breakdown of working  
groups on noise abate-  
ment in the EU<sup>16</sup>.

#### 4.4.2 The 1996 EU Commission Green Book

The EU Green Book identifies noise as an important local environmental concern. Transport is clearly the principal perpetrator, while noise from industry and recreational activities fall far behind it. Noise protection policy would appear to enjoy lower priority than is accorded to air and water pollution.

Previous EU noise abatement measures concerned certification of vehicles and technical improvements at source. The EU is also engaged in research on noise effects, which includes that of multiple acoustic exposure – a theme that Switzerland is also working on.

On the basis of studies and comparative assessments, a rating sound level of 65dB is regarded as generally acceptable, while an exposure level between 55 and 65dB is regarded as substantial. As Swiss investigations have also shown, the disturbance effect of a particular sound level depends on noise category. Thus the Green Book notes explicitly that in some countries, railway noise enjoys a bonus of approximately 5dB over road traffic noise. The report does not mention other 'privileges' (e.g. for aircraft noise).

Overall, the EU Commission anticipates a continuing and unacceptably high level of noise exposure, which is expected to increase further as a result of the increase in the volume of traffic. A further reason for the aggravation of the noise problem is the increase in exposure times, not least as a result of 'just-in-time' production, resulting in increased demands on transport services.

#### 4.4.3 Current EU objectives

Proposals published in July 2000 for a new guideline<sup>12</sup> are of central importance for the assessment and combating of neighbourhood noise. The draft assesses the results of previous activities as being «generally inadequate». The Commission concludes that political inactivity will further exacerbate the noise problem, and proposes a number of «coherent and effective» approaches. These address noise from road traffic, the railways and aircraft in the vicinity of airfields, and emissions from industrial and trades plant.

The guideline proposes harmonisation of the noise indices and assessment methods for neighbourhood noise, and the preparation of information on noise exposure in the form of noise maps. Action plans are to be prepared at local level based on the exposure anticipated. The ramifications of the Commission proposals are as follows:

- $L_{den}$  and  $L_{night}$  are the noise indices to be used in future. Here,  $L_{den}$  is a continuous sound level that weights the various daily intervals (07.00–19.00 hours; 19.00–23.00 hours; 23.00–07.00 hours) differently.  $L_{night}$  is the uncorrected equivalent continuous sound level calculated for 8 night hours over an assessment interval of one year. This appears particularly suited to the assessment of sleep quality and sleep disturbance problems, and problems of falling asleep.
- A phased time plan is provided for preparation of the noise maps, which must be completed by 2010 at the latest. Thus the noise maps for the conurbations must be completed not later than 3 years after introduction of the guideline. The maps must detail the existing and anticipated noise situation on the following counts: noise index, non-compliance, limit values, number of, and impact on, people, number of dwellings, cost-benefit analyses on noise abatement measures or scenarios, etc. The noise maps must be revised every 5 years. Also, there are minimum standards for noise map software. For the preparation of noise maps in border areas, a need for cooperation is foreseen, and this also concerns Switzerland.
- The noise maps form the basis of the action plans. These must be prepared by the end of 2005 at the latest for all of the main highways, main railway routes, major airports and conurbations with over 250 000 inhabitants. The completion date for conurbations with over 100 000 inhabitants is 31.12.2010. All of the action plans must be revised at 5 year intervals.
- Noise maps and action plans must be made available on-line on the Internet or via other channels two months at the latest following their approval.

The new draft guideline does not call into question the sovereignty of individual states. The EU is responsible for the introduction of common indices and calculation and measurement methods, EU-wide monitoring of noise exposure, and strategies for improving the noise situation, the exchange of information and legislation. As far as limit values, noise maps, information of the public, etc., are concerned, the EU will only specify minimum requirements, guiding principles or general objectives. On the basis of this, the member states will develop their own noise abatement approaches and methods.

#### 4.4.4 Future projects

Although Switzerland leads the international field in many areas of noise abatement, present developments in the EU will not be without their consequences for this country. Irrespective of possible future membership of Switzerland in the EU, harmonisation of noise abatement policies must be considered. This is necessary on the one hand on the emission side (type approval for vehicle noise emission) in view of the Federal Law relating to Technical Barriers to Trade. On the other, noise abatement efforts in Switzerland will profit from the synergies resulting from cooperation with the EU. Although noise occurs in most cases as a local phenomenon, it results primarily from global causes (e.g. internal, transit and air traffic). In view of

existing political and economic relations with other countries, a national policy of 'go-it-alone' in the specification of traffic emission restrictions (the principal source of noise) appears illusory.

As a non-member of the EU, Switzerland can at present only participate to a limited extent in European activities. Despite this, she cooperates in standardisation (ECE, VDI, DIN) and in the investigation of health impacts (WHO). In addition, there is a regular exchange of information with foreign research and specialist agencies. This however does not release Switzerland from the obligation to coordinate its noise abatement policies more intensively with the EU. In particular, there is a need for action in connection with future projects as follows:

- Consideration of the consequences of EU policies on content and enforcement of the NAO.
- Coordination of methods of data acquisition and their harmonisation between the EU and Switzerland.
- Extensive participation in European noise abatement activities (science, law, enforcement, information, etc.).
- Cooperation in the establishment of noise maps and action plans in border areas.

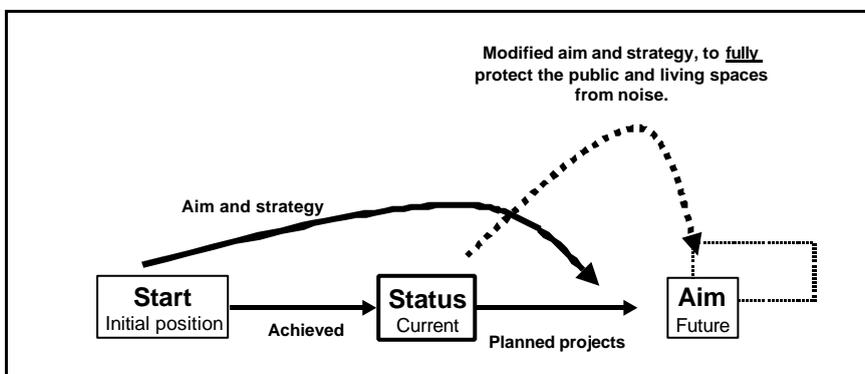


## 5 Critical review of objective and strategy

Noise legislation has the objective of providing «protection of human beings from hazardous or undesired exposure to noise». To achieve this objective, the authorities have in the past performed specific tasks in the areas of 'fundamentals', 'implementation' and 'flanking measures'. By fulfilling these in an optimal fashion, it was expected that the noise problem could be brought under control.

However, the current situation in noise abatement (Chap. 4) clearly shows that although much has been achieved, the goal has by no means been reached, as seen from the fact that large sections of the population are still subject to substantial noise exposure. It should therefore come as no surprise that many people are dissatisfied with current noise abatement policies, since it is clear that existing legislation does not provide adequate protection from noise. Criticism has been voiced that the noise abatement strategy laid down in the LPE and NAO is not adequate, and that the set objectives do not pay sufficient attention to the needs of the population.

From experience gained till now, it is already clear that even when all the existing projects have come to term, the central objective of noise abatement can only partly be realised (Fig. 5.1). The problems arise as a result of the limited objectives and the strategies adopted, restricting noise abatement policy to such an extent that comprehensive protection of the population and the habitat is not possible. Thus there is an evident need to rethink the objective and strategy of noise abatement policy.



**Fig. 5.1**

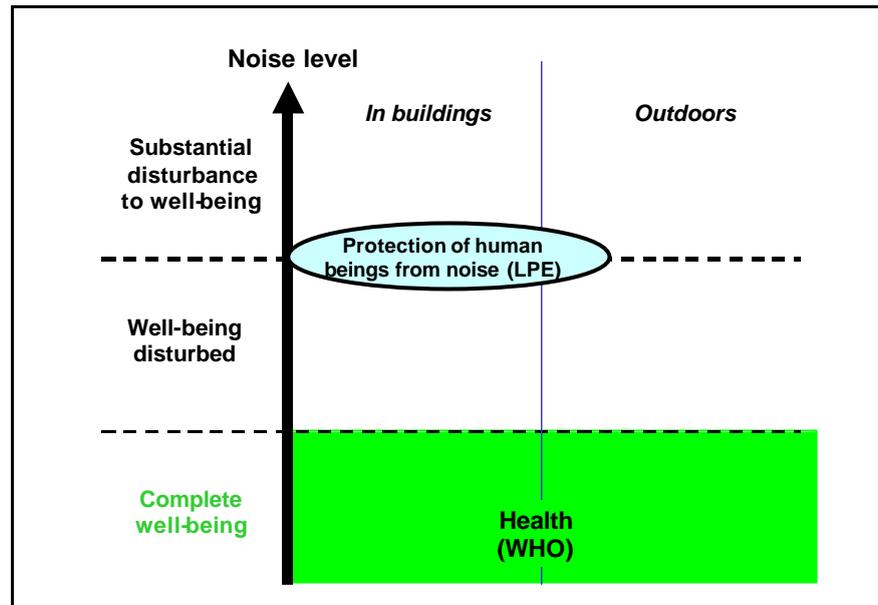
Improved noise protection of the population and the habitat requires not only implementation of the existing projects but also reconsideration of the objective and the strategy.

In the following chapters, the objective and the six principles of the strategy (see Chap. 3) are reviewed in order to identify their strengths and weaknesses and gain new ideas in the interests of a more effective and efficient noise abatement policy.

### 5.1 Analysis of objective

The basic objective of noise abatement is the «*protection from hazardous or undesirable effects, so that the residual exposure does not substantially affect the well-being of the population according to current technology or experience*»<sup>23</sup>. This formulation addresses primarily the psycho-social aspects of health, and in doing so implicitly includes detrimental effects on the body.

**Fig. 5.2**  
Divergence between the LPE protection concept and the WHO definition of health.



It is interesting to compare the definitions of health given by the WHO and the LPE. The expression «state of complete bodily, mental and social well-being» adopted by the WHO (see Chap. 2.2.1) is more far-reaching than that of «significant detriment to well-being» of the LPE. There exists a domain between the two terms «complete well-being» and «significant detriment to well-being», in which the «well-being of the population is disturbed». Under the WHO interpretation, this represents a *de facto* detriment to health.

Furthermore, the 'acceptability threshold' on which the exposure limits are based is not precisely defined, so that for noise exposure in the region of the impact thresholds, 15 to 25% of the population still feel themselves heavily disturbed (see Chap. 5.2.1 (Assessment principles) and Annex A (Determination of exposure limits)). As a result, impairment of the well-being and detriment to the health of large sections of the population could not be prevented even if the provisions of the LPE were to be complied with.

A further important problem arises in connection with the protection concept embodied in the LPE and the NAO. The protection concept focuses mainly on buildings with rooms sensitive to noise, thereby neglecting outdoor living spaces. Also, although noise protection is recognised as an important component of landscape protection<sup>4,10</sup>, the narrow formulation of the NAO restricts noise protection in practice to the installation of noise protection windows and to 'barricading' the population. Thus noise abatement policy lacks the necessary tools to maintain quieter areas and to bring noisy zones back into harmony with the natural 'soundscape'. The widespread desire of the population for a quieter life may be seen as a yearning for a harmonious and natural sound environment. A landscape which is presumed to be 'protected' – and this includes recreational areas bordering residential areas such as gardens, parks and recreational areas – but is subject in reality to continuous noise from cars and jets, cannot satisfy these demands, but on the contrary suffers a loss as a result of the noise.

To find a solution, an extension of the set objectives would appear necessary. Thus to ensure an intact and natural environment for the population, noise abatement policy must be extended beyond the concept of **comprehensive protection of human beings** to include the **protection of whole areas**.

## 5.2 Analysis of strategies

### 5.2.1 Assessment principle

There are two basic problems in assessing noise exposure as follows.

The first is that sensitivity to noise cannot be assessed entirely on the basis of physical sound properties, but is affected by moderating factors (see Chap. 2.2) (although these lessen with increasing sound intensity). This has the disadvantage that it is often only possible to assign part of the 'damage' to those responsible for the noise. This also relativises the impact of noise exposure, and there is a tendency to play down its gravity. Although the causal relationship between noise emission and noise disturbance (dose-effect relationship) is not clearly demonstrable except at high noise intensity, many people feel disturbed at much lower intensities.

Secondly, noise, or sound, are subject to rapid fluctuations. While the level of soil pollution (for example) remains relatively constant for decades or centuries, and the level of air pollution changes over hours or days, noise exposure fluctuates within seconds, making its assessment more complex.

The problem of fluctuating noise intensity may be solved by averaging the sound levels based on their energy content. By this means, the phenomenon may more easily be quantified and is simpler to apply than the time distribution of the sound. However, the averaging process suppresses the peak values and ignores the disturbing effects of intermittency. To account for this effect, the equivalent continuous sound level is weighted by a constant  $K$ , giving a rating sound level of  $L_r = L_{eq} + K$ . The constant  $K$  is dependent on the specific properties of the sound such as its tonal and pulse content. This procedure can only be applied to types of noise that are more or less continuous. In cases where the moderating factors (voices, music, etc.) have a major effect on the sound, this procedure fails. At the present time, no comprehensive or practical solution for consistent assessment of this type of noise is available.

Another problem arises from the practice of assessing the different types of noise independently, since this does not allow for consideration of the effects of combined sources. Also, independent assessment leads to a schism among those protesting against noise, and weakens their opposition. Thus although action groups exist to combat local noise problems, no powerful interregional lobbies have been formed at political level to tackle noise problems as a whole.

A further drawback of the present procedure for assessing the noise nuisance is the dependency of the exposure limits on the exploitation zones. The decision to specify exposure limits in mixed zones (ES III) that are less restrictive than in pure residential zones (ES II), despite the fact that persons in ES III are equally sensitive to noise as those in ES II, is based on economic considerations. The extremely restrained designation of exploitation zones of type ES I is presumably based on similar considerations, the result being that only very few areas have been assigned to ES I in Switzerland.

In assessing the noise nuisance on the basis of limit values, there is a danger that this procedure will be extrapolated to all forms of noise, although this is known to be inadequate in many cases (voices, music, etc.). Thus noise situations of this type are increasingly assessed by means of sound recording. As mentioned in Chap. 4.2.2 (Monitoring), a further disadvantage

of limit values is that they do nothing to prevent the insidious increase in noise exposure in quiet countryside areas. This is true even where the exposure approaches the limit value. There is therefore a need for additional procedures in order to protect quiet areas from noise. Both for residential and countryside areas it is therefore necessary to inquire to what extent the traditional form of noise abatement using limiting sound values should be supplemented by a more active structuring of the acoustic landscape. Here, the so-called 'soundscape' method (see Chap. 2.2) may be applied to alter the moderating factors (that are decisive for assessing the effects of noise), in such a way that the noise present is experienced as a natural sound landscape. Thus, for example, noise barriers that are transparent or have a natural appearance are found to be more effective than concrete structures.

### **5.2.2 Source principle**

The principle of applying measures primarily at source is necessary to protect whole areas from acoustic 'pollution'. However, the legal term 'measures at source' in the NAO is not without its problems. While traffic or speed reductions lead to a proportional reduction in emissions, a noise barrier provides only limited protection to local areas depending on their distance from roads. Despite this, no legal distinction is made between these more or less effective methods.

A further weakness of the source principle is that apart from 'economic acceptability' and 'reasonableness' it specifies no criteria on which to choose between measures at source and those at point of exposure. If it is decided to provide noise protection for the building occupants, this is usually the cheapest procedure. Although the costs of this have to be carried, no further measures are required. The cost progression (i.e. high costs for measures at source, low costs for measures at point of exposure) is diametrically opposed to the source principle, i.e. high priority for measures at source.

### **5.2.3 Prevention principle**

The objective of prevention is to prevent future noise problems and to halt the increasing exposure to noise. To this end, regulations have been introduced for those causing the noise to cover the principal areas (type approval for road vehicles and planning values for new installations). On the exposure side, the Confederation has issued regulations for the assignment, development and building of building zones, and standards for noise protection partitions for new buildings.

In spite of these provisions, loopholes in prevention legislation still exist. Thus no regulations exist for railway vehicles and mobile appliances (lawnmowers, building machinery, etc.) and the measurement methods specified for vehicle type approval do not entirely reflect the everyday situation. Also, economic considerations have led to restrictions on prevention. This is clearly illustrated by the general provision to the effect that noise emissions must be reduced as far as this is technically and operationally feasible and economically acceptable. Particularly for development planning prevention (planning values for new installations), the prevention principle is breached by the possibility of relaxations in cases where the public (and with it, economic) interest is involved. For new private installations for which relaxations (in the range between the planning values and the impact thresholds) have been granted, no protection provisions – i.e. not even the installation of noise protection windows – are required. Only in cases where relaxations have been granted for new public or concessioned plant with noise

levels exceeding the impact thresholds must those causing the noise bear the costs of noise protection measures. Beyond this, no further requirements apply. In distinction, the regulations for the designation and development of building zones in noisy areas, and the erection of buildings in these, are considerably more stringent. Though exemptions are also allowed for these, they are not so far-reaching as in the case of new installations. In other words, restrictive application of the relaxation rule penalises property owners (building prohibition) and the communes (hampering of residential development) to a greater extent than those causing the noise. Further, the manner in which the NAO is applied often hinders comprehensive development of building zones, falsifies the statistics on building land and increases the pressure on undeveloped zones. In general, the problem of noise is insufficiently considered in the sectoral and regional plans, which is tantamount to neglect of the prevention principle in development planning, as shown by recent experience at Zurich airport.

#### **5.2.4 Remediation principle**

The remediation principle is intended to eliminate existing noise problems, and is necessary not only to halt the noise increase, but actually to reduce it. However, the exceptions specified heavily restrict the effectiveness of the remediation principle. These were introduced primarily for economic reasons, although it is true to say that investments in noise protection measures also accrue to the benefit of the national economy and create employment.

Under existing legislation, noise remediation must be carried out if it is economically acceptable and reasonable. If it is not, those concerned can demand relaxation of the regulations. Thus as long as economic interests have priority, noise protection can only partly be enforced.

Also, there exists an inequality of treatment in granting relaxation. Thus for public and concessioned installations, relaxation can go beyond that for private installations, although the former (roads, railways and airfields) are responsible for the major part of the noise nuisance. Moreover, owners who do not remediate installations with emissions lying between the impact thresholds and the alarm values suffer no cost burden, since under environmental legislation, the costs of noise protection windows must only be borne if the *alarm values* are exceeded. Only in cases where a public or concessioned installation is significantly altered, is the public entitled to noise protection measures if the impact thresholds are exceeded. Measures going beyond these are mostly not implemented (e.g. limitation of the relaxation period, compensation for those affected). Till now, delays in remediation work have led merely to the extension of the allowed periods, and have not resulted in sanctions. Concerning the completion dates for remediation, the question also arises as to whether remediation should better be regarded as an ongoing task, since noise protection measures taken in the past could prove insufficient in the wake of changed traffic patterns, increased traffic, etc.

The legal requirement to ensure protection of urban character, nature and the landscape in building construction (and thus also in remediation work) further reduces the effectiveness of noise protection. This situation is a typical conflict of interests, and here, a middle way must be found between the above concerns and the interests of noise protection.

### 5.2.5 Polluter pays principle

The polluter pays principle states that the costs associated with the avoidance, remediation or toleration of environmental pollution must be borne by those causing the pollution, and not by those affected or by the general public. This means that the external costs arising from activities detrimental to the environment must be internalised, and this is also laid down in legislation (polluter pays principle). The principle is justified both on economical and ecological grounds. However, the version laid down in the LPE represents a narrow interpretation of the polluter pays principle, since the polluter must bear only the costs of the measures that are required in law.

Under current provisions, the polluter pays principle is only implemented in respect of the costs arising for noise protection measures. For private installations, the owner must carry the costs. For public installations, the Confederation, the cantons and the communes, being the owners, must shoulder the noise costs. The authorities themselves can pass on their expenditure to the users of the installations, as is to some extent the case with road noise remediation. The Confederation carries part of these costs and finances them using revenue from the mineral oil tax. With the railways, the Confederation also carries the costs of noise remediation. In respect of the major concessioned airports at Zurich and Geneva, the measures are partly financed through special landing charges for noisy aircraft.

In some cases, the polluter pays principle is breached. For example, for costs arising from buildings erected in areas affected by noise, it is not applied. Thus if the authorities specify that for a new building the rooms sensitive to noise must be situated to face away from the source of the noise, or structural or restructuring measures are required, it is the owner of the building who must bear the supplementary cost of the necessary measures and not the party responsible for the noise.

Also, current provisions do not cover the so-called 'external noise costs', such as those arising from health detriment to the population affected. Further, the depreciation of property due to noise exposure is not covered. In individual cases, a suit can be filed to recover the costs under other legislation (e.g. right of expropriation), and – as estimates for the national airports show<sup>3</sup> – this may result in substantial costs.

Cost disposal via the party responsible for the noise may also be considerably hampered by the circumstance that as a rule only general cost estimates are available. Indeed, how could the detailed costs – for example the health costs – be determined in any particular case? Initial efforts to account for the noise problem in life-cycle assessments have been made<sup>19</sup>, but these are insufficiently advanced to allow practical application. For the particular case of the health impact of noise – which also includes the noise nuisance – methods for the monetarisation of health impairment and for financial compensation are called for.

### 5.2.6 Cooperation principle

Noise abatement in Switzerland is based on a decentralised approach, comprising a specialist environmental agency at SAEFL and several other specialist centres having enforcement duties under the Confederation and the cantons. This organisational form is in harmony with Switzerland's political structure that encourages participation and cooperation among the

players, the resulting synergies leading to cost savings in implementation. Also, other authorities are concerned with specific aspects of noise abatement (see Chap. 2.3).

However, the involvement of so many players in noise abatement leads to higher expenditure, and there is a tendency towards fragmentation and dissipation of effort. Particularly in the case of transportation facilities, the enforcement authorities are confronted with contradictory requirements. Thus on the one hand there is the need to promote transport, but on the other to order operational measures in the interests of noise limitation, which may lead again to transport restrictions. As a result, conflicting interests are not always resolved in an open and objective manner, and in some cases the interests of noise protection are neglected in favour of transport promotion.

Fragmentation also occurs owing to the many areas touched by noise abatement. Optimum procedures call for intensive interdisciplinary cooperation, which is not always achieved in practice. Thus noise abatement measures are all too often planned on a strictly acoustic basis, regardless of the fact that a holistic approach would often provide a better solution.

The justified demands of those suffering from noise are also fragmented at institutional level by the independent assessment and combating of the various types of noise (i.e. road noise by local authorities, railway noise by the Confederation, etc.). This partly explains why those living in the vicinity of a firing range (for example) hardly take an interest in the noise problems in the neighbourhood of a shunting yard. In this way, the political influence of the groups affected by noise is weakened. The extensive noise from air traffic leads to somewhat more 'justice', engendering greater solidarity in the regions affected. Indeed, wealthy property owners are often the staunchest noise opponents, rightly fearing a devaluation of their property.

Against this background, it is understandable that political efforts<sup>24</sup> are being undertaken to discourage the ETH Council in its endeavours to relieve the EMPA of its responsibility for noise abatement, and to transfer the department elsewhere.

Cooperation problems also exist between the Confederation and the cantons, notwithstanding the fact that there is excellent understanding among the specialist agencies and among the political bodies. Disagreement can however occur *between* the specialist agencies and the political bodies, and this principally reflects a conflict of interest between the requirements of environmental legislation and economic concerns.



## 6 Perspectives in noise abatement

### 6.1 Summary

Experience with noise abatement following introduction of the NAO has shown that the principles applied are basically right. Among these, the most effective have proved to be the dose-effect relationship based on socio-acoustic research, noise protection primarily at source, prevention (particularly in development planning), noise remediation of existing plant, shifting of the costs to those responsible for the noise, and cooperation among the players involved. This set of instruments puts Switzerland in an excellent position to tackle the noise problem. The present report also demonstrates that noise abatement in Switzerland is anchored not only in the specialist noise agencies of the Confederation, but also in those of the cantons. Work on fundamentals, implementation and flanking measures is well advanced, making possible the enforcement of preventive and remediative noise abatement measures.

**Overall, it can be said that noise abatement in Switzerland – particularly in comparison to the EU – is relatively well advanced, but not as advanced as would be necessary to provide comprehensive protection of the population.**

The inquiry carried out in Chapters 4 and 5 on noise abatement points to substantial weaknesses in the following areas:

**Objectives:**

- the protection concept embodied in the LPE concentrates not so much on entire landscapes but mainly on the living space within buildings, leading on the one hand to an insidious increase in noise exposure within the country, and on the other to 'barricading' of the population;
- the principle of noise protection laid down in LPE proves to be more lenient than would be necessary according to the WHO definition of health.

**Problem perception (strategy) :**

- the existing assessment principle is not yet sufficiently comprehensive, and is not applicable to all noise situations. Also, proof of the disturbance, damage and costs caused by noise is not yet sufficiently detailed;
- noise monitoring procedures in Switzerland (emissions, exposure, population affected) are inadequate in obtaining an up-to-date – and comprehensive – perspective and are unsuitable for making international statistical comparisons.

**Problem solutions (strategy) :**

- Existing noise legislation suffers from the following gaps;
- the difficulties encountered with the enforcement of noise protection, and particularly of remediation, have till now been underestimated. Particularly for roads, additional measures for accelerating remediation are called for in order to complete the work within the foreseeable future;

- the polluter pays principle in the LPE is very narrowly formulated, so that not all noise costs are covered. Also, there is practically no economic incentive to reduce noise and its consequences;
- noise abatement is heavily undermined and restricted by virtue of the exemptions that may be granted;
- efforts to reduce noise at source, particularly applied to emission limitation on vehicles and appliances, are not yet being adequately pursued;
- the supply of information and education opportunities on noise are very limited and need expanding;
- the interdisciplinary nature of the problem, coupled with the large number of players involved, plus the fragmented and weak noise lobby, all militate against effective coordination, the result being that noise abatement policy in Switzerland is unsatisfactory. Furthermore, noise abatement is only modestly coordinated with other countries.

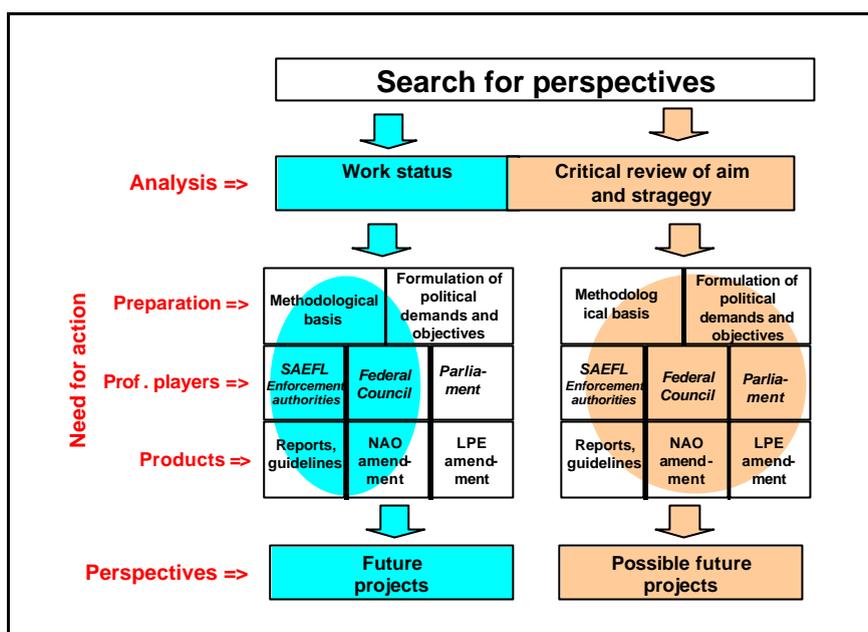
In view of the weak points identified above, solutions must be sought that help remedy existing deficiencies, but which do not sacrifice the present strengths of noise abatement policy. The resulting procedural modes will permit more effective and efficient protection of the population from noise disturbance.

## 6.2 Novel approaches

The search for perspectives in future noise abatement may be divided into two components (Fig. 6.1).

As shown in the analysis of work status in Chapter 4, detailed projects are in the pipeline that are intended to close the loopholes in noise abatement and invigorate the crusade against noise. These projects cover to a large extent the need for action resulting from the noise abatement procedures laid down in law. The projects in question concern methodological fundamentals, optimisation of enforcement, guidelines and ordinances. Implementation of these can be achieved in the middle term.

The second component of future procedural modes results from a critical analysis of objective and strategy. Here, there is an additional need for action to better protect the public from noise. Most of the projects considered for this require more extensive fundamental research, modifications at administrative level and possibly even amendments to the Law relating to the Protection of the Environment (requiring prior formulation of demands and objectives at political and social levels). The resulting proposals must outline the available scope for action in noise abatement in Switzerland. Whether or not the proposals are politically realisable cannot be assessed here.



**Fig. 6.1**  
Novel approaches in future noise abatement.

The 'future projects' and the 'possible further projects' embody the potential perspective in noise abatement. It is not possible to present ready-made and detailed methods, as this would exceed the bounds of the present report. Instead, the proposals made should be understood as an incentive to those involved in noise abatement in their efforts to achieve a quieter and more natural environment.

## 6.3 Perspective in noise abatement

### 6.3.1 Perspectives concerning the Objective

Concerning the objective, there are two perspectives based on the spatial and temporal extension of noise protection (Z1) and on the nature of the protection concept (Z2).

#### Z1: Protection of habitats

Switzerland is subject to increasing noise exposure. Previous measures to combat noise were mainly directed towards protecting human beings, mainly in buildings. In future, noise abatement must be directed towards the protection of entire landscapes (including recreational areas bordering residential areas), thereby protecting the habitats both of human beings and animals.

However, a solution to this cannot be found based the limit values previously applied, that were based on a technological approach. This is not possible because the relationship between the physical landscape and the natural 'soundscape' is too complex. Required is a new vision arising from the concept of a 'confort sonore' to account for the aesthetic features of the habitat. Populated habitats are clearly distinguished by their 'acoustic design'. Human perceptions of 'acoustic backgrounds' present in the city or a mountain village differ widely. This concept may be applied to unpopulated areas, which often serve as recreational areas.

The methods necessary to protect entire landscapes will in future place greater demands on noise abatement than was previously the case in the technically oriented environment then prevailing. Future long-term noise abatement policy must be ready to develop the concept of noise protection to encompass natural soundscapes. This includes temporal aspects such as the maintenance and extension of periods of quiet. In an initial phase, it will be the task of research to identify soundscape typologies and to develop measures permitting harmonisation of the physical and acoustic landscapes.

The advantages of this procedure for health are many. Additionally, the spatial and temporal extension of noise protection will benefit both regional planning and development planning in the communes.

**Z2: Modification of the LPE protection concept to correspond to the WHO definition of health**

The present report has demonstrated that the protection concept embodied in the LPE and its practical application (e.g. in the specification of exposure limits) contradicts the WHO definition of health. For noise protection in the longer term, the LPE definition of health must be modified to correspond to, or at least be brought into line with, the WHO concept. The fundamental concept of noise abatement is therefore moving away from the idea of 'protection from excessive noise' towards that of a 'right to quiet'. The more progress that is made in eliminating enforcement deficits and conceptual inadequacies, the greater will be the need for noise protection to be oriented towards the WHO specifications. Until this is the case, the intervening time should be utilised for political persuasion.

Optimisation of the noise abatement concept will not only benefit those affected by noise (e.g. improved health protection), but also have positive effects on traffic behaviour patterns. It may also be expected that the search of the population for quieter areas – one of the most important reasons for the increase in traffic – will decline with improved noise protection. This effect is therefore self-amplifying, since the decrease in traffic volume results in a decrease in noise emission.

### **6.3.2 Perspectives concerning problem perception**

Problem description may be divided into two parts:

**S1: Extension of the assessment principle**

The assessment principle, which is mainly concentrated at present on the main types of noise (roads, railways, airfields, industrial and trades installations and firing ranges), must be applied to further types of noise such as that from sports and voices. In addition to the purely acoustical aspects, 'moderating factors' must be included to take account of the relationship between cause and effect. Also, situative assessment using acoustic recordings must be increasingly considered, since even though a noise nuisance can hardly be quantified with mathematical precision, this will enable the disturbance to be made more tangible.

Additionally, the assessment principle must be extended to account for the overall effect of several different types of noise. This procedure must be particularly considered at places where the noise from transportation facilities such as airfields, roads and railways already approaches – or even exceeds – the limiting values. The assessment principle must also be extended to 'vibrations and radiated structure born sound' to ensure that the population is also protected in this area.

Although the numerous effects of these are known qualitatively, a quantitative knowledge that would enable the effects to be assessed is lacking. In particular, there is need of a common denominator enabling the effects to be considered *en bloc* so that they can be compared and documented. In future, additional efforts will be required to determine the costs of noise exposure more precisely. In addition to monetarisation of the health costs, the costs of social segregation, devaluation of property and real estate, and the effects on development planning resulting from noise will require more detailed determination. The determination of total costs will create suitable conditions for the enforcement of the polluter pays principle. This will provide noise protection policy with a tool that will help to ensure equality of treatment – or at least more just conditions – in the progress of reconciling the interests of noise protection and commerce.

**S2: Improvement in monitoring**

In monitoring, significant knowledge gaps have been identified. These extend from fundamental questions of the effects of noise through to performance control of the measures introduced. This conclusion applies not solely to the Swiss situation, as shown by efforts to establish a monitoring system in the EU. There is therefore an urgent need to improve the monitoring methods and extend the associated control instruments for assessing the effects, costs and effectiveness of the measures applied. In this connection, geographical information systems (GIS) are increasingly available for the comprehensive documentation of important data obtained from calculation – this to be tested on a case-by-case basis based on long-term measurement. The most important data are cartographically classified data on emissions, exposure and numbers affected. Conceivable are also evaluations and effects of noise exposure on residential development. The transition from noise plans in paper form, which are still in widespread use, to electronic systems will permit simplification of storage and maintenance of noise data. Further, computer technology permits a significant improvement of the services necessary to administrate this data. Thus effective monitoring is now supplemented by a practical tool enabling the public, as well as decision makers in politics and commerce, to be better informed of the noise problem and to be sensibilised to the requirements of noise abatement.

It is not essential that the various enforcement agencies apply the same system in implementing this program, since available technology offers sufficient flexibility to couple the data of the various players. Of eminent importance is the readiness of the various enforcement agencies to cooperate. Thus although the effects of noise are confined to certain areas, effective control is only possible if the problem is tackled from a Swiss-wide perspective.

In addition to conceptual and technical problems, noise monitoring is confronted by questions of finance. In accordance with Article 6 LPE (Information and Consulting), SAEFL is obliged to inform the public at intervals on the status of environmental pollution control and of temporal and spatial changes in this. Data for this are provided by the measurement stations of the National Monitoring Network for Air Pollution (NABEL) and the NAQUA project for groundwater measurement. Owing to the fact that noise monitoring is highly complex and must have access to development planning data, the collaboration of the cantons is essential. To allow valid conclusions to be drawn from noise monitoring in Switzerland as a whole, Federal funding must be available to cover the costs of the cantonal agencies.

### 6.3.3 Perspectives concerning problem solution

The following seven perspectives are available for problem solution:

- completion of projects planned to close gaps in legislation (S3);
- assurance of enforcement of noise protection, particularly for remediation measures (S4);
- extension of the polluter pays principle (S5);
- specification of more restrictive provisions for relaxations (S6);
- reinforced efforts to combat noise at source (S7);
- extension of the information and education programmes on noise (S8);
- reinforcement of noise abatement coordination in Switzerland and internationally (S9).

#### **S3: Closure of legal loopholes**

Following introduction of the NAO, work began on emission regulations for vehicles and appliances, and on exposure limits for the principal categories of noise. This work will be completed in the near future. Specifically, Annex 7 of the NAO will be extended to cover exposure limits for civil firing ranges. This regulation is intended to take account of the increasing use of sports weapons. The amendment will not affect the completion date for remediation in 2002. In addition, certain legislative changes to the noise exposure register are intended. The regulations governing road noise remediation will also be optimised (see S4).

In a second phase, the specification of exposure limits for the noise from military firing ranges and training grounds is planned in a further Annex to the NAO. In addition, the existing regulations on aircraft noise are to be extended to permit the enforcement authorities to take account of the combined noise exposure from military and civil airfields.

In parallel to the work on the NAO, SAEFL is preparing an ordinance relating to the protection of the population from vibrations and radiated structure born sound. Concerning emission regulations, the EU provisions on type approval and labelling of appliances (lawnmowers, building machinery, etc.) will be adopted and cast in the form of an ordinance. For railway vehicles, basic work is in progress on the specification of noise emission limits. Concerning noise protection in buildings, SAEFL is participating in the revision of SIA standard no. 181, representing an important step in prevention.

#### **S4: Enforcement of noise protection**

Consistent enforcement of the NAO and of the remediation work in all parts of Switzerland will continue to be an important theme at SAEFL in the future. Major tasks concern the largest sources of noise, since both for roads and railways, the remediation period of 15 years following introduction of the NAO originally specified cannot be complied with owing to delays in remediation.

The remediation project for the railways (remediation of rolling stock by 2009 and preparation of structural noise protection measures by 2015) is assured by virtue of the FinöV financial plan. The Swiss Federal Office of Transport (FOT) is responsible for enforcing the remediation work, and SAEFL for assuring compliance with the environmental regulations. Also, SAEFL is responsible for the specification of emission limit values for railway vehicles.

For roads, a decision is pending on extension of the remediation date. Experience following entry into force of the NAO shows, however, that the mere extension of a deadline does not guarantee completion of the work within the period foreseen. This is particularly the case for roads in urban areas, since the motorways and federal highways received priority treatment

under previous measures. To guarantee the remediation of road noise within the newly extended periods, further acceleration measures will be needed.

**S5: Extension of the polluter pays principle**

In its present form, the LPE does not provide for comprehensive implementation of the polluter pays principle, despite the fact that Article 74 Paragraph 2 of the Constitution goes further. Efforts are therefore necessary to ensure that the totality of noise costs is in future carried by those responsible for the noise.

A precondition for this is that the costs resulting from the noise are known. If these can be spelt out to those responsible, their payment will generate the necessary pressure to reduce the noise. To implement the polluter pays principle, economic instruments may also be considered. Firstly, these must assure the financial conditions under which reduction or avoidance of noise would result in economic benefit. Those responsible for the noise would be motivated to produce less noise, not only out of respect for others, but because of the concrete financial advantage to be gained. Secondly, these instruments permit the entire noise costs to be passed on to those responsible. An example of this approach towards noise reduction is provided by the noise charges at airports. Although this is a measure limited to the locality, it will undoubtedly have a broader effect in the long term.

Contrary to this, the compensation payments that are being increasingly discussed in connection with noise are not considered to be economic instruments in the classical sense. Although under these, those responsible for the noise incur a financial burden due to their emissions, the revenue accruing does not fall to the benefit of noise protection, but is paid out for the 'toleration' of noise exposure. This neither leads to a reduction of noise, nor is there any direct financial interest on the part of those responsible to undertake further efforts towards noise reduction following payment of compensation.

An alternative to this might be a 'noise loan'. Interest would have to be paid on this, but it would also be possible, as a second option, to provide for full repayment in the form of adequate noise reduction. In the same way as for a house mortgage, interest would have to be paid on the outstanding debt to those affected. Measures to reduce noise would therefore represent repayment (amortisation) of the debt

There is also potential for the introduction of economic instruments to create suitable conditions enabling the polluter pays principle to exert a greater influence. The cost sequence which militates against this principle could be eliminated by requiring that the difference between the costs for measures at source and those of the measures effectively taken be paid into a fund. The revenue from this fund would of course have to be reserved for noise abatement uses. A further possibility is the granting of remediation relaxations (see S6) and the issue of emission regulations for vehicles and appliances. For this, the Confederation could prefer a noise tax (in the sense of a preventive measure), which however should accrue entirely to the benefit of noise abatement.

At present, there are no federal projects planned for the introduction of economic instruments for noise abatement. Preparatory work is being concentrated on methods for calculating certain components of the total noise cost. In future, consideration will have to be given to the question of how to pass on the noise costs to those responsible in an economically acceptable way in order to enforce the polluter pays principle.

**S6: More restrictive provisions for relaxations**

The 'relaxation loophole' may at present be exploited at small penalty, since for public and concessioned installations, the cost of noise protection windows must be carried by the owners of the installations. It will therefore be necessary to fill the exemption gap that exists between the impact thresholds and the alarm values by introducing stricter provisions. It is also necessary to subject the relaxations as a whole to closer scrutiny. However, as it does not at present appear possible to remove the relaxations, future noise policy must create effective mechanisms to ensure that those responsible for the noise have an ongoing interest in further reducing it after the relaxations have been granted. Possible approaches are to limit the period of validity of relaxations and to introduce economic restrictions to create the necessary pressure to reduce noise.

**S7: Noise abatement at source**

Technical measures to reduce noise at source represent one of the most efficient means of reducing noise exposure over wide areas. However, the regulations on emission limitation (type approval) in Switzerland have to be compatible with the EU, reducing the leeway for more stringent regulations. Incentive instruments must nevertheless be sought within the existing framework to ensure that not only the classical performance characteristics of vehicles and appliances, but also their noise generation are considered. In addition to stricter type approval regulations, alternative ways are available to promote low-noise technologies. Thus, for example, financial incentives for the intensified application of low-noise technologies could lead in the long run to a situation where users recognise a quieter vehicle as a significant advantage.

This requires that in addition to incentives and regulations to promote low-noise technologies, consultation services be available to provide the necessary know-how, and this in its turn presupposes increased research effort in Switzerland, not only by private consultants, but also by EMPA.

**S8: Expansion of information and education**

In future, information on the theme of noise will be provided via all media (reports, brochures and teaching materials). Services will be expanded particularly on the Internet, and here, cooperation with the cantonal enforcement authorities and those of the Confederation is planned. The main objective is to sensibilise the public more fully to the environmental impact of noise by providing more and better information.

Education and training offer further opportunities for information transfer in noise abatement, and particularly the education of specialists at university level. The outcome of the expert report of 1963 was the establishment of the Department of Acoustics/Noise Abatement at the EMPA – a major success of the noise protection campaign in Switzerland. Despite the fact that there are significant gaps in basic research, and that EMPA is a recognised and independent competency centre and constitutes a central pillar in noise abatement, discussions are currently in progress on whether or not to continue this activity.

Over and above promotion of training activities in noise abatement and acoustics, endeavours must be made not only to maintain, but also to expand, the technological and scientific sectors. As a further perspective, an interdisciplinary chair for 'noise' at an advanced education college is desirable. Owing to its research tradition and the proximity to the EMPA, the ETH in Zurich would seem the most suitable location for this.

**S9: Coordination**

Owing to the strongly interdisciplinary nature of this work, there is a danger of fragmentation, and resolute coordination of noise abatement is called for. Coordination should not, however, be equated with concentration – or indeed centralisation – in the tasks of those involved. This is because the methodology of noise abatement must be closely coupled with the sectors causing the noise (roads, railways, aviation, etc.). To ensure a consistent procedure and an optimum deployment of resources, the programs and activities of the various areas must be more closely coupled to ensure that a clear 'unité de doctrine' arises in noise abatement policy.

To this end, institutional instruments in the form of working groups, coordination commissions and information services (with the necessary competencies) must be created. An example of this is the Federal Commission for the Assessment of Noise Exposure Limits ('Eidgenössische Kommission für die Beurteilung von Lärm-Immissionsgrenzwerten'), which by virtue of its interdisciplinary constitution and new tasks can provide a significant contribution to improved integration of the various areas. The interaction between enforcement, development planning, landscape protection, the economy and technical noise abatement will thereby become significantly more efficient and effective. Synergies can also be exploited by virtue of closer cooperation with the activities of SUVA (noise protection at the workplace) and SFOPH (protection from hearing damage from excessively loud noise). Thanks to this cooperation, the problem of noise abatement will be increasingly perceived in its totality, leading to a significant strengthening of the 'lobby for quiet'.

In addition to the improvement of national coordination, interrelations at political and economic levels, and international collaboration at ecological level are urgently needed. In the field of noise abatement, too, it is recognised that although noise mostly manifests as a local problem, the steady increase in traffic – one of the main causes – represents a cross-frontier phenomenon. For Switzerland, closer cooperation on noise abatement within the relevant institutions of the EU is in the forefront. International cooperation must also be considered for the specification of emission limits for vehicles, in research and in harmonising the methodology.

Owing to non-membership of Switzerland in the EU, cooperation is mainly limited at present to technology and science. Political efforts will therefore be required in the long term to ensure that Switzerland not only profits from the synergies of a consistent European noise abatement strategy, but may also take part in its development.

## 6.4 Conclusions and further steps

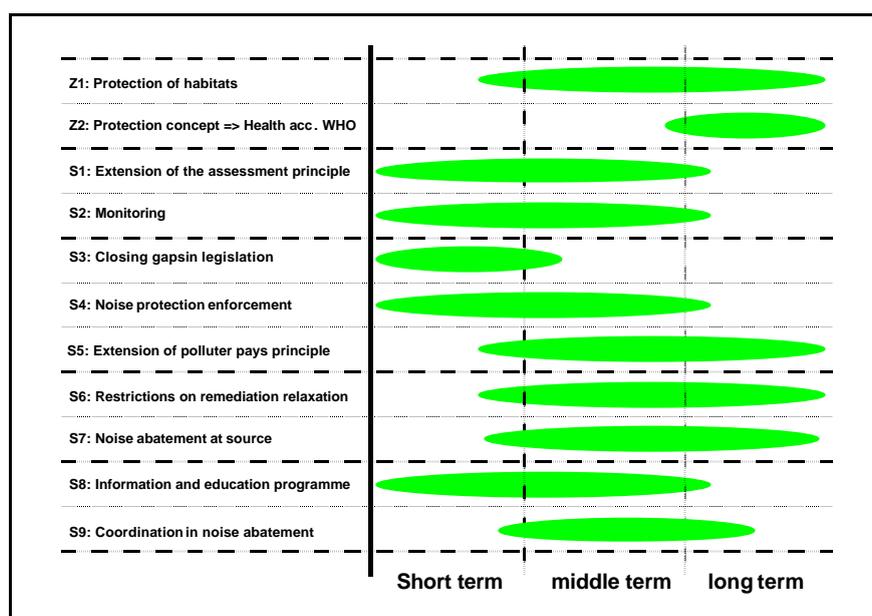
In presenting viable perspective in noise abatement, detailed projects were not included. This would exceed the bounds of the present report. It was nevertheless possible to present fundamentals that will provide those affected, and particularly the professional players, with pointers to future developments in noise abatement. Spelling out these perspectives in detail will be a task for all those involved, particularly for the cantons.

This work must begin now. To provoke a rethink on the part of large sections of the population, new fundamental research projects and sensibilisation in the political field must be considered. As shown by experience of environmental protection in Switzerland, it has in recent decades proved repeatedly possible to motivate society in favour of comprehensive programmes to combat grave environmental deficits. Prominent examples of this are the progress in the areas

of water protection, waste disposal and air pollution control. A further large step must now be urgently considered for noise protection. In the wake of the programme for noise remediation of the railways, and increasing protests against aircraft noise, the time for this now seems ripe. With a coherent noise abatement policy, the quality of life in Switzerland will improve and economic advantages will accrue.

Fig. 6.2 shows a rough breakdown of the time scale for further steps. The objective is to extend noise protection in the middle to long term to all living spaces, and in the long term, attempts will be made to bring the protection concept in the LPE into line with that of the WHO definition of health.

**Fig. 6.2**  
Possible time scale for the implementation of perspectives in noise abatement.



In the strategic sector, efforts will be concentrated in the immediate future on closing gaps in noise legislation. Moreover, fundamental research is in progress in the areas 'extension of the assessment principle', 'monitoring', 'noise protection enforcement', and 'extension of the information and education programme'. In the short to middle term, improvements to 'coordination in noise protection', and in the middle to long term, proposals for methods of problem solution in the areas 'extension of the polluter pays principle', 'restrictions to relaxations' and 'noise protection at source' will be required.

A rough breakdown of the principal players involved in implementation of the perspectives the various areas is shown in Fig. 6.3.

The projects on 'objectives' are of a fundamental nature, requiring not only efforts on the part of the authorities and the Government, but also an expression of political intent by parliament. For the 'extension of the polluter pays principle', 'restrictions to relaxations' and improvements to 'coordination of noise protection' and 'noise protection at source', legislative amendments will probably be required. The projects in the remaining areas can be implemented at the level of reports, guidelines or ordinances as required in law (LPE).

Sectors	<u>Authorities</u>	<u>Federal Council</u>	<u>Parliament</u>
	Reports, guidelines	NAO amendment	LPE amendment
Z1: Protection of habitats	██████████	██████████	██████████
Z2: Protection concept => Health acc. WHO	██████████	██████████	██████████
S1: Extension of the assessment principle	██████████	██████████	
S2: Monitoring	██████████	██████████	
S3: Closing gaps in legislation	██████████	██████████	
S4: Noise protection enforcement	██████████	██████████	
S5: Extension of polluter pays principle	██████████	██████████	██████████
S6: Restrictions on remediation relaxation	██████████	██████████	██████████
S7: Noise abatement at source	██████████	██████████	██████████
S8: Information and education programme	██████████	██████████	
S9: Koordination der noise abatement	██████████	██████████	██████████

**Fig. 6.3**  
Participation of the principal players in implementing procedural modes in noise abatement.

The closing remarks of the report on 'Noise Abatement in Switzerland' of 1963 may be cited here: «The realisation of the proposed perspective will entail the expenditure of considerable time, money and effort, but the health and well-being of the population are values for which no effort should be spared in order to secure them.»



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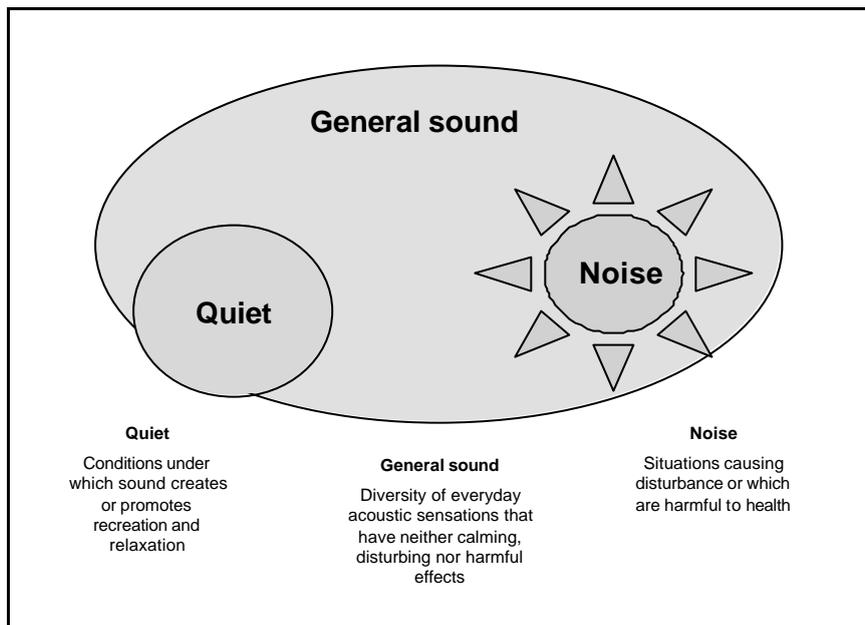
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## Annex A: Material basis of noise abatement

### Distinction between sound, quiet and noise

Sound is a physical quantity, and therefore free of value judgements. It takes the form of pressure fluctuations that manifest as waves in a carrier medium (e.g. air, water or solid body). The relevant properties of sound waves are the sound pressure (pressure variations), spectral properties (frequency) and time distribution.



**Fig. A1**  
Distinction between sound, tranquillity and noise<sup>13</sup>.

The distinction between the two opposite properties of sound, i.e. quiet and noise (Fig. A1) is made on the basis of human perception and assessment. Quiet can mean the absence of sound, a condition which hardly occurs in nature. In a state of 'practical quiet', existing sound is perceived as pleasant and relaxing. In the negative sense, disturbing sound or sound hazardous to health is designated as noise<sup>13</sup>.

### Vibrations and radiated structure born sound

Ground vibrations (or simply vibrations) are mechanical vibrations in solid bodies. For greater precision, vibrations are often designated as disturbing or undesirable mechanical vibrations, whereby, however, these terms are not used by all authors in the same sense.

Radiated structure born sound is the sound emitted by solid bodies caused by ground and other vibrations. A well-known example of this is the vibrating washing machine, whose vibrations lead to a noise nuisance in other rooms or apartments by virtue of the vibrating walls. Radiated structure born sound is usually treated in the same way as noise transmitted through the air from the source to the receiver.

The principal source of vibrations in the environment are the railways. Further sources are building machinery and industrial works. As opposed to noise, remediation of vibrations involves extensive work, and measures to combat it must therefore be introduced at an early stage in the construction of installations.

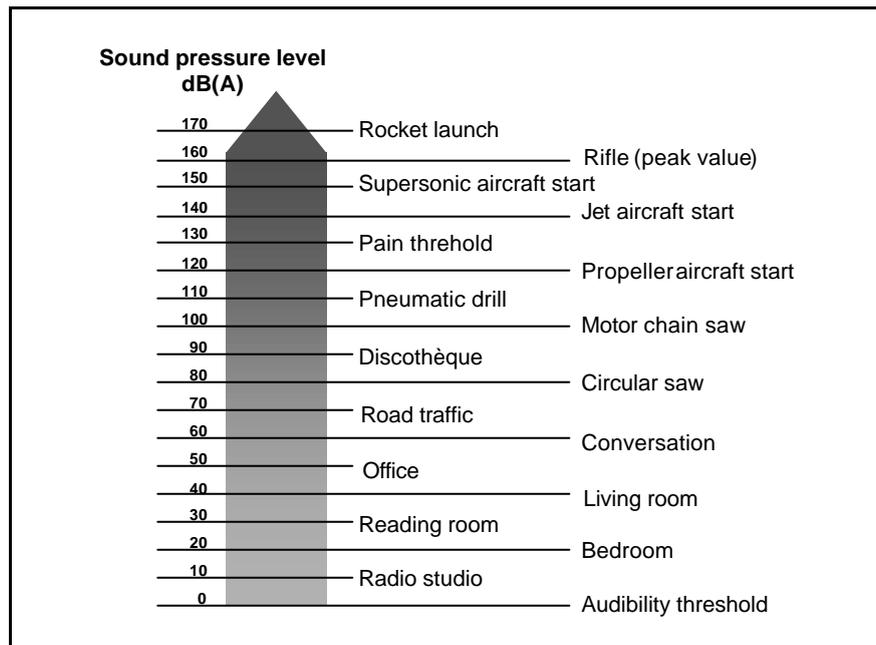
## Sound pressure

The unit of sound pressure is the pascal ( $1\text{Pa} = 1\text{N/m}^2$ ). The human ear can perceive sound pressures in the range  $2 \cdot 10^{-5}$  Pa (just audible) to 100 Pa (pain threshold). This very large range of some seven powers of ten is somewhat ungainly for practical use, so that a logarithmic representation is chosen in place of the pascal. For this, the hearing threshold ( $p_o$ ) is chosen as the normalising factor for sound pressure  $p$ :

$$L = 10 \log\left(\frac{p^2}{p_o^2}\right)$$

The quantity resulting from this calculation is described as the 'decibel', whose range extends from 0 to 130dB(A) for normal hearing.

**Fig. A2**  
Illustration of different sound pressure levels.



In fact, the decibel is not strictly speaking a unit, but is used in this sense in acoustics. Note in particular that in adding several sources of noise, the logarithmic dB values cannot simply be added, but the calculation must be performed via the original values of sound pressure (or more precisely, via the sound energy as a function of  $p^2$ ).

## Addition of sound levels

The sum  $L$  of two (non-coherent) noise sources with sound levels  $L_1$  and  $L_2$  may be calculated according to the following formula:

$$L = 10 \log(10^{L_1/10} + 10^{L_2/10})$$

When two sources of sound are equally loud, the resulting sound level is 3dB higher than the separate sound levels.

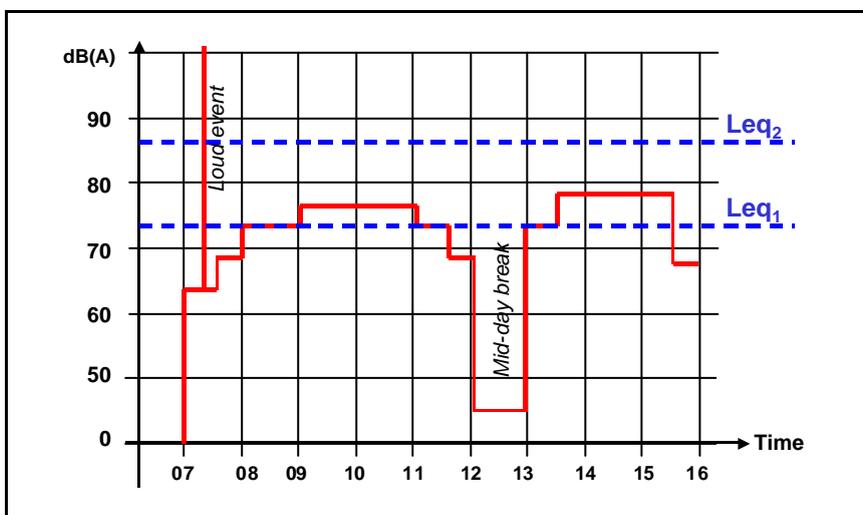
## Filter characteristics

The sensitivity of our hearing depends on frequency. Sensitivity is greatest at around 4000Hz, while at 100Hz, for example, it is some 20dB lower. This dependency on frequency must be taken into account in assessing sound level, and this is achieved by using a suitable filter. The most frequently used filter is the A filter, and this method is known as A weighting. The sound level determined using this filter characteristic is identified by the adjunction of an A in brackets, e.g.  $L_{eq}(A)$ .

## Equivalent continuous sound level

Many sound sources vary with time, making it difficult to specify a general sound level. For these, the energy for the sound source is averaged over a certain time period and converted to a so-called 'equivalent continuous sound level' or 'energy-equivalent continuous sound level',  $L_{eq}$ .  $L_{eq}$  has the same acoustic energy as the original source over the time period considered. The  $L_{eq}$  level is also specified in dB.

Fig. 3 shows the effect of variations in the sound level at an office workplace on the equivalent level. Ignoring the loud event at 07.20 hours, an equivalent level of  $L_{eq1}$  results. Note that the mid-day break has practically no effect on this. If the loud event at 07.20 hours is included, an equivalent level  $L_{eq2}$  results, showing how a loud event affects the equivalent level. This is attributable to the high sound energy of the peak sound level of the loud event.



**Fig. A3**  
Calculation of the equivalent continuous sound level ( $L_{eq}$ ) from the time distribution of the sound.

Thus the equivalent continuous sound level  $L_{eq}$  combines periods of quiet, the frequency of sound events and the peak levels in a single quantity. It is well suited for describing sound exposure over a defined time period. However,  $L_{eq}$  is not suitable for describing all situations. If, for example, very loud events occur, these can lead to hearing damage or waking reactions in sleep, which cannot be derived from the equivalent level. In these cases (e.g. rifle noise and sleep disturbance), a more suitable measure is the peak level  $L_{max}$ .

## Rating sound level

Because not all types of noise (e.g. from roads, railways and firing ranges) have the same disturbance or nuisance potential, the noise exposure indicator in noise abatement is normalised. This is likewise based on the equivalent continuous sound level  $L_{eq}$ , but is here supplemented by a correction factor depending on noise category. The resulting measure is referred to as the rating sound level  $L_r = L_{eq} + K$ , also specified in decibel.

## Further rating levels

There exist a plethora of further measures of noise disturbance. Thus  $L_1$  is the level that is only exceeded during 1% of the measurement period. This therefore represents a measure of the peak level. Likewise,  $L_{10}$  is the level that is exceeded for 10% of the measurement period.

Until May 2000, the assessment of aircraft noise in Switzerland was based on the noise and number index NNI. NNI has two parts: an event frequency and a peak level. As only events above 68dB(A) are considered, it is suitable for describing exposure to aircraft noise at close range, but not at a distance.

In a draft guideline submitted to the EU Commission for the harmonisation of noise abatement<sup>12</sup>, a 24 hour index ( $L_{den}$ ) and a night index ( $L_{night}$ ) are proposed. In  $L_{den}$ , the day is divided into three phases: day = 12h, evening = 4h and night = 8h. The noise exposure index is based on the equivalent continuous sound level, whereby the evening hours are subject to a deduction of 5dB and the night hours to a deduction of 10dB.

$$L_{den} = 10 \log \left( \frac{1}{24} \left( 12 \cdot 10^{\frac{L_{day}}{10}} + 4 \cdot 10^{\frac{L_{evening}+5}{10}} + 8 \cdot 10^{\frac{L_{night}+10}{10}} \right) \right)$$

$L_{night}$  is the A weighted equivalent continuous sound level averaged over one year, and applies only to a night-time duration of 8 hours.

The selection of noise exposure indicators is very large. Numerous studies have however shown that their contribution to disturbance levels is relatively modest (quoted variance approx. 30%). To put it in other terms: the probability of correctly predicting disturbance based on noise exposure alone is relatively low. Comparisons between different measures have shown that these correlate strongly among one another. This means in practice that the choice of noise exposure indicator is less significant than might be assumed from the many disputes on the correct measure to apply. For this reason, and owing to its simple determination by measurement or calculation,  $L_{eq}$  is increasingly accepted internationally as a basis for noise assessment. If the EU guideline mentioned above is adopted,  $L_{den}$  will in the long term become the accepted measure in Europe.

## Measurement and calculation

There exists a myth concerning noise measurement. Many laypeople believe that noise disturbance can only be determined by measurement. And although experts would not dispute that measurements are necessary and justified, they argue that they are often imprecise, time-consuming, manpower-intensive and therefore expensive.

Advances in IT now make it possible to model noise disturbance analytically. Today, comprehensive simulation programs are available, enabling both individual noise situations and entire noise exposure registers to be calculated. The importance of noise measurement has therefore declined. It is still used today for planning noise protection measures and for validating the results of simulations in cases of dispute.

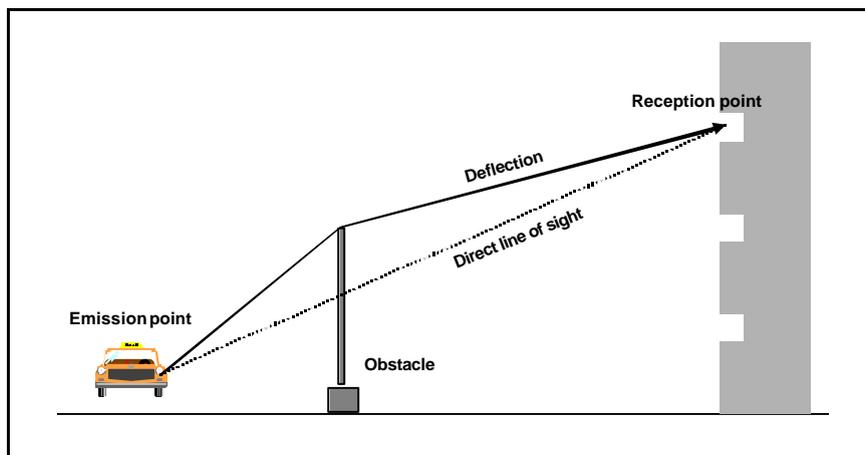
## Sound dispersion

In considering sound dispersion, effects such as attenuation, refraction and reflexion must be considered.

Sound waves are attenuated in the propagation medium (air, water, structure). Thus their intensity falls with increasing distance from the source. Attenuation depends not only on the medium, but also on the physical dimensions of the sound source. If the distance from the source in the air is doubled, the sound level is reduced by 3dB for a line source (e.g. road) and by 6dB for a point source (e.g. hovering helicopter).

Sound waves are deflected by an obstacle in their path (see Fig. A4), i.e. the sound beam 'curves' around the obstacle, so that the noise may be perceived although there is no direct line of sight.

Where sound waves impinge on a surface, part of the sound is reflected from the surface depending on its properties. This effect must be considered with noise barriers to ensure that areas opposite are not affected by the reflected sound.



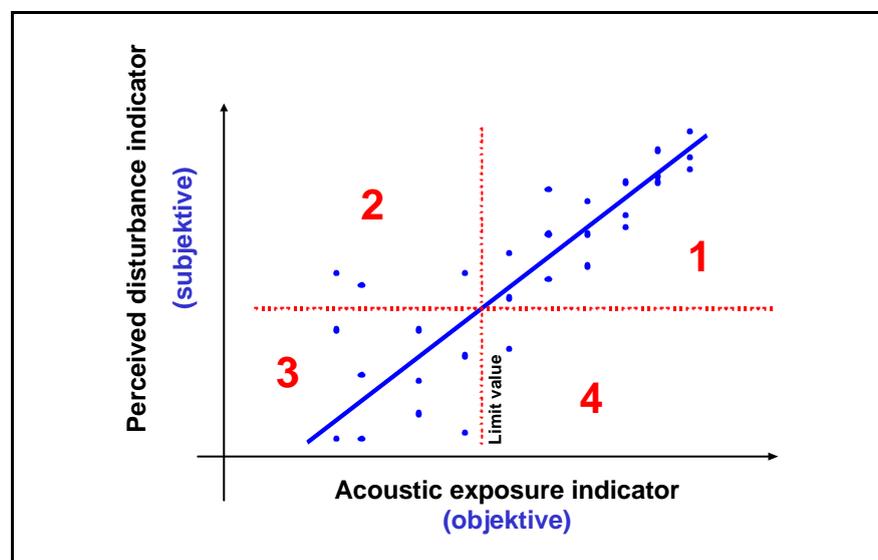
**Fig. A4**  
Sound deflection.

## Determination of exposure limits

The problem in determining exposure limits is to establish a relationship between a particular (objective) acoustic exposure and a (subjectively) perceived disturbance. Also, an exposure limit must be laid down for which the disturbance is substantial or unacceptable.

The statistical correlation between acoustic exposure and perceived disturbance is not very great, since noise perception differs from person to person and from one study to another. Also, the mathematical relationship is only very approximately linear, as shown in Fig. A5. It is the task of data analysis to determine the relationship more precisely. In order to establish equitable limit values, an analytical model is required providing the best possible statistical relationship between the two variables.

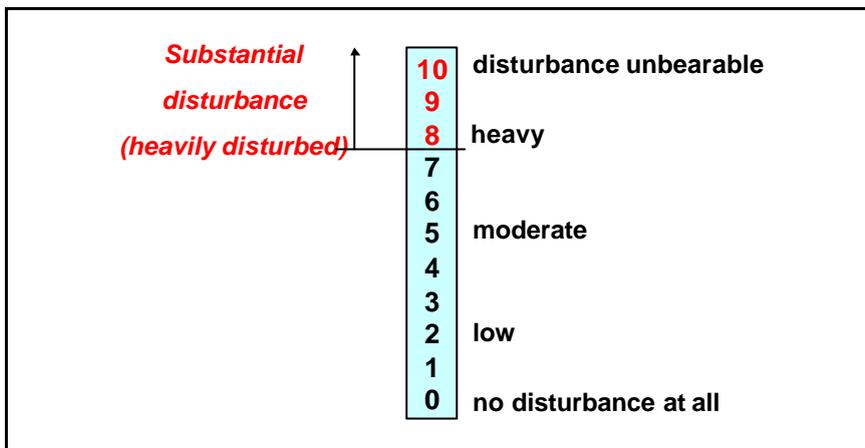
**Fig. A5**  
Relationship between exposure and disturbance.



The specification of a limit value is equivalent to setting a limit based on a defined criterion. According to art. 15 LPE, the criterion for the impact threshold is that of 'substantial disturbance'. That is to say, the impact threshold must be set based on current technology or experience, so that exposure below this value does not cause substantial disturbance to the population in its well-being<sup>23</sup>.

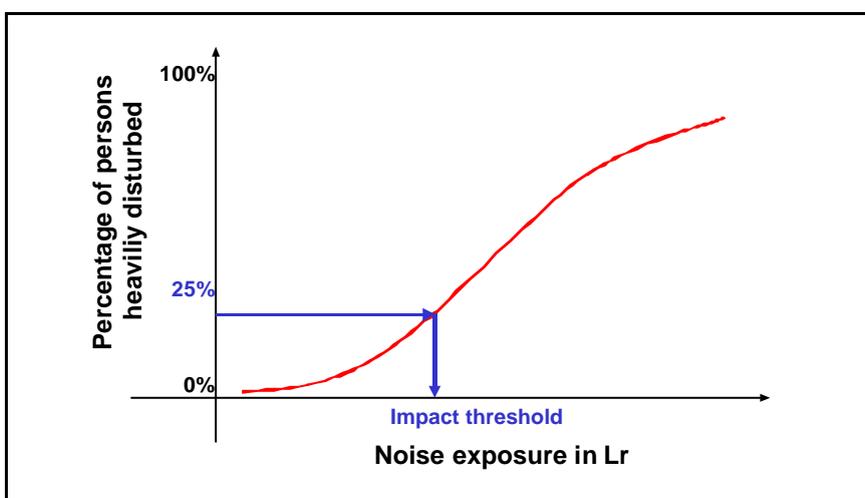
The strengths and weaknesses of the limit value principle are illustrated by the four rectangles in Fig. A5. Persons in rectangle 1 are subject to noise exposure above the limit value, and are heavily disturbed by noise. This is the main group to be protected by this principle. Persons in rectangle 2, though not subject to exposure above the limit value, still feel themselves to be heavily disturbed. This group is not protected by the limit value principle. Those in rectangle 3 are less affected owing to the lower noise level. Persons in rectangle 4, though subject to noise above the limit value, experience only slight, or no, noise disturbance. Nevertheless, the question of health impairment also arises for this group.

In Switzerland, the rating sound level  $L_r$  is used as the acoustic indicator. The subjectively perceived disturbance is established from surveys using a representative sample of persons affected. These give the degree of disturbance on a scalometer, where responses of 8, 9 and 10 on the scale represent substantial noise disturbance (Fig. A6).



**Fig. A6**  
Scalometer for recording the disturbance of persons affected by noise.

As the responses of those questioned vary greatly, there exists an unwritten convention in Switzerland to set the impact threshold at the point where at least 15 to 25% of those effected feel themselves to be heavily disturbed (divisions 8 to 10 on the scale) (Fig. A7). This convention is not universally accepted, since it implies that a quarter of the affected population is still heavily disturbed despite compliance with the limit value. Nonetheless, this procedure has proved acceptable in practice.



**Fig. A7**  
Determination of the impact threshold at the point where 15 to 25% of the population are still heavily disturbed.

The impact threshold determined using this procedure applies to residential areas (ES II). For quiet zones (ES I), the value is set 5dB lower. Zones with mixed use (residential and industrial uses, ES III), the value is set 5dB, and for industrial areas (ES IV), 10dB higher.

No surveys are carried out in determining the planning and alarm values. In general, the planning values are set 5dB below the impact thresholds, ensuring that the total noise from several installations still remains below the impact thresholds. Values of noise exposure lying between 5 and 10dB above the impact thresholds are regarded as being in need of urgent remediation, so that the alarm values are set in this range.

The above procedure may be applied for the determination of limit values for day-time noise. At night, the limit values are either set 5 to 10dB lower, or based on the waking reaction during sleep.

As an example, Fig. A8 gives the limit values for road, railway and industrial and trades installations. Further details, particularly concerning correction factors, are given in the annexes to the NAO.

**Fig. A8**  
Limit values according to the Noise Abatement Ordinance (example for road traffic noise).

*Rating sound level  $L_r$*   
*Day:=06-22 Uhr; Night:=22-06 Uhr*

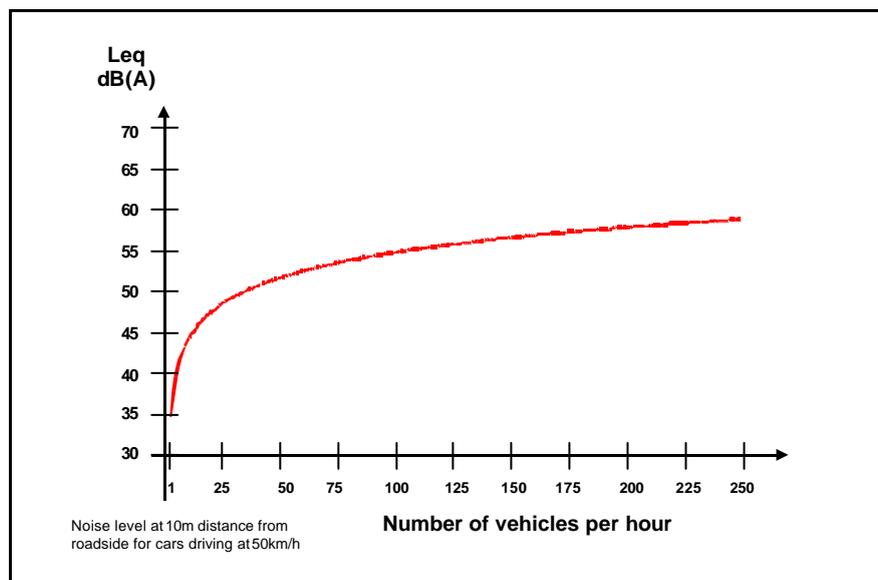
Sensitivity category	Planning value		Impact threshold		Alarm value	
	Day	Night	Day	Night	Day	Night
ES I	50	40	55	45	65	60
ES II	55	45	60	50	70	65
ES III	60	50	65	55	70	65
ES IV	65	55	70	60	75	70

### Noise abatement measures

The most efficient measure in noise abatement to reduce emissions, i.e. realisation of technical or operational measures to ensure that the noise source is as quiet as possible. After this, the next step is to take measures along the propagation path. These are equivalent in law to emission reduction, since they can protect extensive areas from noise.

The effect of operational measures is illustrated in Fig. A9. This shows the noise exposure at a distance of 10 metres from a road as a function of the number of cars per hour.

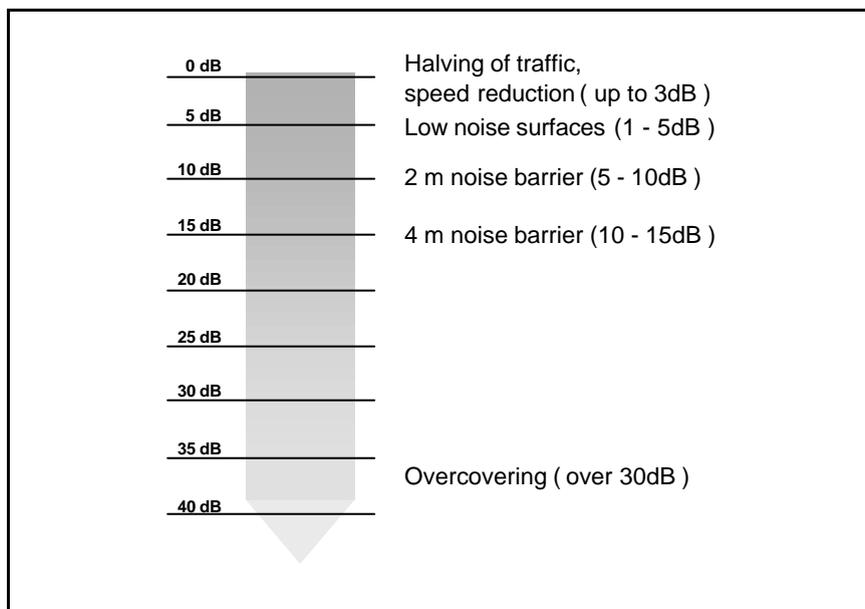
**Fig. A9**  
Influence of vehicle frequency (vehicles per hour) on noise exposure at a distance of 10 metres from the road.



Considering that halving the volume of traffic 'only' reduces exposure by 3dB, relatively drastic operational measures must be taken to significantly reduce noise exposure in the vicinity of busy roads. From a noise abatement standpoint, shifting of traffic to roads that are already heavily frequented can prove effective, if lightly frequented roads are thereby spared additional traffic.

The effects of a selection of classical measures are shown in Fig. A10. Note that effective noise abatement cannot be achieved by individual measures alone, but only by a combination of several measures. In addition to the protection objective, the cost-benefit ratio<sup>5</sup>, i.e. the relationship between the cost of measures and the financial benefit of the noise reduction (depreciation of real estate), is an important aspect.

For exposure protection, the only option in most cases is to install noise protection windows. Although these provide protection of the order of 30dB, this only applies within the buildings. Noise protection measures in buildings are therefore regarded as a last resort in noise abatement, providing at least a minimum of protection.



**Fig. A10**  
Effects of various noise protection measures.

Measures additional to those mentioned above may be applied in development planning. Thus by avoiding residential building in noisy areas, and by careful positioning of the rooms sensitive to noise, future noise problems may be effectively avoided.

## Annex B: Legislation on noise abatement

### Swiss Law

#### Federal Constitution

[Art. 74](#) *Environmental protection*

- 1 *The Confederation shall legislate on the protection of man and the natural environment against harm and nuisance.*
- 2 *It shall ensure that such influences are avoided. The polluters shall pay for the costs of avoidance and removal.*
- 3 *The federal regulations shall be implemented by the Cantons, insofar as the statute does not reserve this for the Confederation.*

#### Environmental legislation

[814.01](#) Federal Law relating to the Protection of the Environment; of 7 October 1983 (Environmental Protection Law; LPE).

[814.41](#) Noise Abatement Ordinance of 15 December 1986 (NAO)

[814.49](#) Sound and Laser Ordinance of 24 January 1996

[814.011](#) Ordinance relating to the Environmental Impact Assessment of 19 October 1988 ('Verordnung über die Umweltverträglichkeitsprüfung')

[742.144](#) Federal Law relating to Railway Noise Remediation of 24 March 2000 ('Bundesgesetz über die Lärmsanierung der Eisenbahnen')  
Ordinance relating to Railway Noise Remediation of ('Verordnung über die Lärmsanierung der Eisenbahnen')

#### Swiss Civil Code (ZGB)

[Art. 684/679](#) *III. Neighbourhood law*

#### Development planning legislation

[700](#) Federal Law on Spatial Planning of 22 June 1979 (RPG)

[700.1](#) Ordinance relating to Spatial Planning of 28 June 2000 (RPV)

#### Road transport legislation

[741.01](#) Law relating to Road Transport of 19 December 1958 (SVG) ('Strassenverkehrsgesetz')

[741.11](#) Ordinance relating to the Highway Code of 13 November 1962 (VRV 1) ('Verkehrsregelverordnung')

[741.41](#) Ordinance relating to technical Requirements for Road Vehicles of 19 June 1995 (VTS) ('Verordnung über die technischen Anforderungen an Strassenfahrzeuge')

[741.412](#) Ordinance relating to technical Requirements for motorised Transport Vehicles and their Trailers of 19 June 1995 (TAFV 1) ('Verordnung über technische Anforderungen an Transportmotorwagen und deren Anhänger')

[741.413](#) Ordinance relating to technical Requirements for agricultural Tractors of 19 June (TAFV 2) ('Verordnung über technische Anforderungen an landwirtschaftliche Traktoren')

- [741.414](#) Ordinance relating to technical Requirements for Motorcycles and lightweight, small and three-wheel Motor Vehicles of 2 September 1998 (TAFV 3) ('Verordnung über technische Anforderungen an Motorräder, Leicht-, Klein- und dreirädrige Motorfahrzeuge')
- [741.51](#) Ordinance relating to the Authorisation of Persons and Vehicles to use the Roads of 27 October 1976 (VZV) ('Verordnung über die Zulassung von Personen und Fahrzeugen zum Strassenverkehr')
- [741.511](#) Ordinance relating to the Type Approval of Road Vehicles of 19 June 1995 (TGV) ('Verordnung über die Typengenehmigung von Strassenfahrzeugen')
- [510.710](#) Ordinance relating to Military Road Transport of 17 August 1994 (VMSV) ('Verordnung über den militärischen Strassenverkehr')

#### **Railway legislation**

- [742.101](#) Law relating to the Railways of 20 December 1957 (EBG) ('Eisenbahngesetz')
- [742.31](#) Federal Law relating to the Swiss Federal Railways of 20 March 1998 (SBBG) ('Bundesgesetz über die Schweizerischen Bundesbahnen')

#### **Cable railway legislation**

- [743.25](#) Ordinance relating to subsidised Aerial Cable Railways for Passenger Transport without Federal Concession of the EVED (former Federal Department of Transport and Energy) of 24 October 1961 ('Verordnung über subventionierte Luftseilbahnen mit Personenbeförderung ohne Bundeskonzession des EVED')

#### **Air transport legislation**

- [748.0](#) Federal Law relating to Aviation of 21 December 1948 (LFG) ('Bundesgesetz über die Luftfahrt')
- [748.01](#) Ordinance relating to Aviation of 14 November 1973 (LFV) ('Verordnung über die Luftfahrt')
- [748.112.11](#) Ordinance relating to the Fees of the Federal Office of Civil Aviation of 25 September 1989 (VGZ) ('Verordnung über die Gebühren des Bundesamtes für Zivilluftfahrt')
- [748.121.11](#) Ordinance relating to Traffic Rules for Aircraft of the DETEC of 4 May 1981 (VVR) ('Verordnung über die Verkehrsregeln für Luftfahrzeuge des UVEK')
- [748.121.12](#) Ordinance relating to Noise-Associated operational Restrictions on Jet Aircraft of 23 February 1994 ('Verordnung über lärmbedingte Betriebseinschränkungen für Strahlflugzeuge')
- [748.131.1](#) Ordinance relating to Aviation Infrastructure of 3 November 1994 (VIL) ('Verordnung über die Infrastruktur der Luftfahrt')
- [748.215.3](#) Ordinance relating to Aircraft Emissions of 10 January 1996 (status as of 4 July 1996) ('Verordnung über die Emissionen von Luftfahrzeugen (VEL)')

#### **Inland shipping legislation**

- [747.201](#) Federal Law relating to Inland Shipping of 3 October 1975 (BSG) ('Bundesgesetz über die Binnenschifffahrt')
- [747.201.1](#) Ordinance relating to Inland Shipping of 8 November 1978 (BSV) ('Binnenschifffahrtsverordnung')

- [747.223.1](#) Ordinance of the International Shipping Commission relating to Shipping on Lake Constance (Lake Constance Shipping Rules) concluded on 13 January 1976, approved by the Federal Council on 17 March 1976 ('Verordnung der Internationalen Schifffahrtskommission über die Schifffahrt auf dem Bodensee')
- [0.747.221.1](#) Agreement between the Swiss Federal Council and the Government of the French Republic relating to Shipping on Lake Constance ('Abkommen zwischen dem Schweizerischen Bundesrat und der Regierung der Französischen Republik betreffend die Schifffahrt auf dem Genfersee')
- [0.747.221.11](#) Regulations relating to Shipping on Lake Geneva concluded on 7 December 1976 by the Federal Assembly, approved on 27 February 1978 ('Reglement über die Schifffahrt auf dem Genfersee')
- [0.747.223.11](#) Agreement relating to Shipping on Lake Constance concluded on 1 June 1973 by the Federal Assembly, approved on 26 June 1974 ('Übereinkommen über die Schifffahrt auf dem Bodensee')
- [0.747.225.1](#) Agreement between Switzerland and Italy relating to Shipping on Lago Maggiore and Lake Lugano concluded on 2 December 1992 by the Federal Assembly, approved on 16 December 1993 ('Abkommen zwischen der Schweiz und Italien betreffend die Schifffahrt auf dem Langensee und dem Luganersee')
- [747.301](#) Ordinance relating to Ocean Shipping of 20 November 1956 ('Seeschifffahrtsverordnung')

#### **Schiesswesen**

- [510.10](#) Federal Law relating to the Army and the Military Administration of 3 February 1995 (MG) ('Bundesgesetz über die Armee und die Militärverwaltung')
- [510.512](#) Ordinance of the Federal Military Department relating to Firing Installations for off-duty Firing Practice of 27 March 1991 (SchAV) ('Schiessanlagen- Verordnung des EMD über die Schiessanlagen für das Schiesswesen ausser Dienst')

#### **Protection of health in the building industry**

- [842](#) Federal Law relating to Measures for the Promotion of Residential Building of 19 March 1965 (WFG) ('Bundesgesetz über Massnahmen zur Förderung des Wohnungsbaues')
- [842.2](#) Ordinance relating to Federal Assistance for the Promotion of Residential Building of 22 February 1966 ('Verordnung über Bundeshilfe zur Förderung des Wohnungsbaues')
- [843.1](#) Ordinance relating to the Law relating to the Promotion of Residential Building and Home Ownership of 30 November 1981 ('Verordnung zum Wohnbau- und Eigentumsförderungsgesetz')
- [0.822.722.0](#) Agreement No. 120 relating to the Protection of Health in Commerce and in Offices of 8 July 1964 ('Übereinkommen Nr. 120 über den Gesundheitsschutz im Handel und in Büros')

#### **Employee protection**

- [822.11](#) Federal Law relating to Workplaces in Industry, the Trades and Commerce of 13 March 1964 (ArG) ('Bundesgesetz über die Arbeit in Industrie, Gewerbe und Handel')

- [822.113](#) Ordinance No. 3 relating to the Law relating to Workplaces of 18 August 1993 (ArGV3) ('Verordnung 3 zum Arbeitsgesetz')
- [819.1](#) Federal Law relating to the Safety of technical Equipment and Appliances of 19 March 1976 (STEG) ('Bundesgesetz über die Sicherheit von technischen Einrichtungen und Geräten')
- [832.20](#) Federal Law relating to Accident Insurance of 20 March 1981 (UVG) ('Bundesgesetz über die Unfallversicherung')

## EU law

Number	Keyword	Title	Notes
70/157	Motor vehicles: Exhaust system	Council Directive 70/157/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the permissible sound level and the exhaust system of motor vehicles.  <i>Official Gazette No. L 042 of 23/02/1970 p. 0016–0020</i>	
74/151	Agricultural tractors	Council Directive 74/151/EEC of 4 March 1974 on the approximation of the laws of the Member States relating to certain parts and characteristics of wheeled agricultural or forestry tractors  <i>Official Gazette No. L 084 of 28/03/1974 p. 0025–0032</i>	
77/311	Employees: Agricultural tractors	Council Directive 77/311/EEC of 29 March 1977 on the approximation of the laws of the Member States relating to the driver-perceived noise level of wheeled agricultural or forestry tractors  <i>Official Gazette No. L 105 of 28/04/1977 p. 0001–0009</i>	
78/1015	Motorcycles: Exhaust system	Council Directive 78/1015/EEC of 23 November 1978 on the approximation of the laws of the Member States on the permissible sound level and exhaust system of motorcycles.  <i>Official Gazette No. L 349/21 of 13.12.1978</i>	replaced by 97/24
80/51	Subsonic aircraft	Council Directive of 20 December 1979 on the limitation of noise emissions from subsonic aircraft  <i>Official Gazette No. L 018 of 24/01/1980 p. 0026–002</i>	
86/188	Employees: Workplace	Council Directive of 12 May 1986 on the protection of workers from the risks related to exposure to noise at work  <i>Official Gazette No. L 137 of 24/05/1986 p. 0028–0034</i>	possibly to be inserted in 89/391
86/594	Household appliances	Council Directive 86/594/EEC of 1 December 1986 on airborne noise emitted by household appliances  <i>Official Gazette No. L 344 of 06/12/1986 p. 0024–0027</i>	non-obligatory Directive
89/391	Employees	Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work  <i>Official Gazette No. L 183 of 29/06/1989 p. 0001–0008</i>	still no mention of noise (in revision)
89/629	Subsonic jet aircraft	Council Directive 89/629/EEC of 4 December 1989 on the limitation of noise emission from civil subsonic jet aeroplanes  <i>Official Gazette No. L 363 of 13/12/1989 p. 0027–0028</i>	

Annex B: Legislation on noise abatement

Number	Keyword	Title	Notes
92/14	Chapter 2: Aircraft	Council Directive 92/14/EEC on the limitation of the operation of aeroplanes covered by Part II, Chapter 2, Volume 1 of Annex 16 to the Convention on International Civil Aviation, second edition (1988) <i>Official Gazette No. L 076 of 23/03/1992 p. 0021–0027</i>	
92/61	Two and three-wheel motor vehicles	Council Directive 92/61/EEC of 30 June 1992 relating to the type-approval of two- or three-wheel motor vehicles <i>Official Gazette No. L 225 of 10/08/1992 p. 0072–0100</i>	necessary for 97/24
94/25	Recreational craft	Directive 94/25/EC of the European Parliament and of the Council of 16 June 1994 on the approximation of the laws, regulations and administrative provisions of the Member States relating to recreational craft <i>Official Gazette No. L 164 of 30/06/1994 p. 0015–0038</i>	
97/24	Two and three-wheel motor vehicles	Directive 97/24/EC of the European Parliament and of the Council of 17 June 1997 on certain components and characteristics of two or three-wheel motor vehicles <i>Official Gazette No. L 226 of 18/08/1997 p. 0001–0454</i>	main Directive, refers to 92/61
00/14	Noise emission from 'outdoor' equipment	Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors <i>Official Gazette No. L 162 of 03/07/2000 p. 0001–0078</i>	replaces 9 older Directives
00/194	Environmental noise	Directive of the European Parliament and of the Council relating to the Assessment and Management of Environmental Noise	proposal