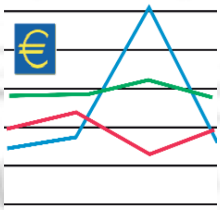
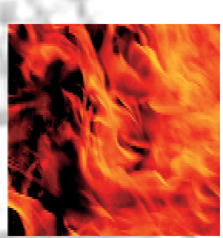
Bundesministerium
für Verkehr, Bau- und
Wohnungswesen

Guideline for Sustainable Building





Guideline for Sustainable Building

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PREFACE

Today, the test of any policy is whether, and if so how, it preserves the opportunities available to future generations. This is particularly true of such concrete spheres as building. If we wish to guarantee economically, socially and ecologically sustainable development in our country, we have to start at a number of different points. In this context, the "Guideline for Sustainable Building" also provides a specific set of requirements to be met by construction.

It makes its contribution by providing practical guidance for the design and management of federally owned landholdings, including a checklist. Its introduction will implement a strategy for federal building works which will gear the design, construction and use of buildings and landholdings to sustainability, with the main emphasis put on the ecological and economic aspects. One of the practical implications of this is, that even at the design stage of a building, the economic impact of specific measures, for instance ecological measures, has to be taken into account and an optimum strategy for investment sought. All this saves money, protects the environment and conserves scarce resources. The most important thing is that all persons involved cooperate at an early stage in the design and construction of a building.

For this, and for much else besides, the guideline contains an enormous amount of information, principles and benchmarks. It is designed to serve as an aid in implementing the "holistic" approach in federal building projects.

By publishing the guideline for federal buildings, we are continuing the approach we have already adopted to ensure sustainability in the building sector.

Kurt Bodewig
Federal Minister of Transport,
Building and Housing

CONTENTS

TERMS OF REFERENCE

1.

Buildings and outdoor facilities on federal landholdings

This guideline is a working aid for the design, construction, maintenance, operation and use of federal landholdings and buildings in accordance with the RBBau.

INTRODUCTION

2.

Implement the concept of sustainability in building projects

This guideline is intended to implement integrated principles for the sustainable planning, construction, operation, maintenance and use of buildings and landholdings.

Reduced consumption / resource flow management

Sustainable building strives to minimise the consumption of energy and resources for all phases of the life-cycle of buildings - from their planning and construction through their use, renovation and to their eventual demolition. It also aims to minimise any possible damage to the natural environment.

This can be achieved by applying the following principles during the entire building process:

- Lowering the energy demand and the consumption of operating materials
- Utilisation of reuseable or recyclable building products and materials
- Extension of the lifetime of products and buildings
- Risk-free return of materials to the natural cycle
- Comprehensive protection of natural areas and use of all possibilities for space-saving construction

Improve overall economic efficiency

The early implementation of sustainable planning measures can considerably improve the overall economic efficiency of buildings (costs of construction, operation, use, environment, health as well as non-monetary values).

When assessing economic efficiency, not only must the overall economic efficiency of the project be guaranteed, but the economic efficiency of every individual planning step must also be assessed in accordance with § 7 BHO.

Direct the design team towards the idea of sustainability

In order to do so, the design team should consist of experts from the various disciplines under the leadership of the planner responsible for the overall co-ordination, and they should work closely together towards the aims of sustainability. Users and operators of the building must also be involved in the design phase.

Quality assurance

Quality assurance includes measuring, documenting and monitoring the results of the construction and the use of the building, and reconciling these results with the design requirements (monitoring).

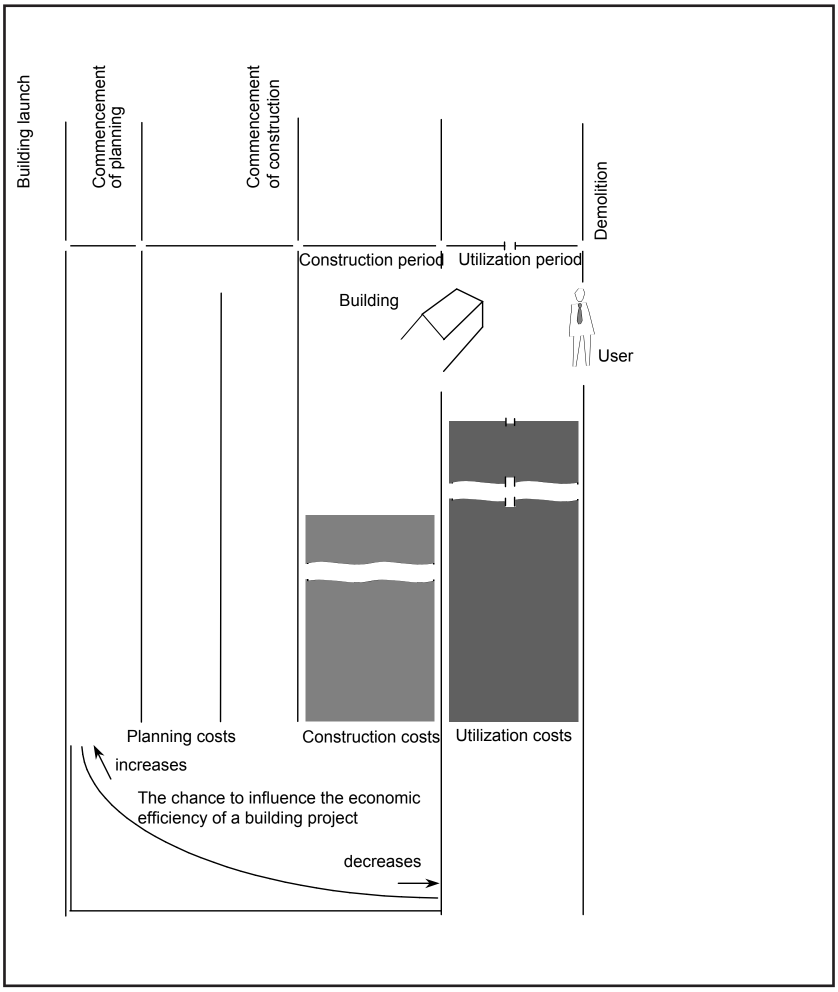

Figure 1:
The Cost Blocks during the Planning, Construction and Utilisation Phases and the Opportunity to influence these [Source: Handbook for an Economic Building Design: Attempts at a Cost Information System accompanying the Design and Building Processes, Paper on Engineering Economy, Vol.1, Wuppertal, German Consulting Publisher 1976, P.4, Fig. 7, Prof. Dr. Karl Heinz Pfarr]

Observe the principles of sustainability from the very beginning

The opportunities for modifying the costs of a project are greatest at the beginning of the project. To a large extent, the cost-effective decisions will have been made during the definition of the programme and the initial concept phase. The same is also true for the impacts to the environment. Questions such as site development as well as planning law, function, urban planning, architecture and building regulations (especially stability and fire safety) must be fully assessed and optimised in terms of sustainability during the preliminary design and architecture and engineering competition stages.

Socio-cultural aspects have equal weight

Sustainable planning requires that equal consideration is given to the socio-cultural effects of the building project. Besides integration into the urban and natural environments, consideration must also be given to those aspects that affect people, such as the design of the building and the preservation of historic buildings and monuments.

Long-term use

Usually, buildings are used for long periods of time (on average 50 - 100 years). The temporal criteria, which are to be applied in the framework of the ecological and economical assessments, should be designed accordingly.

Consider each single measure separately

Sustainable building cannot be achieved by following a rigid concept. Instead, a specific concept or partial concepts must be developed for each individual project, and these concepts should include different approaches, alternatives and measures for the project.

3. PLANNING PRINCIPLES

3.1 GENERAL

The following cascade proceeds from the general to the specific issues:

Assessment of needs - new construction
Is a new building necessary in order to meet the space requirements, or can use be made of existing assets?

Optimisation of the development programme
Is the development programme designed to fulfil requirements that are actually needed?
Does the planned allocation of space support the working processes (optimised path connections)?

Consider site-related effects
Does the site support the ecological (impact/equilibrium/traffic flow/site reutilisation/construction on contaminated sites) and economic requirements?

Optimise building design
Optimise the design of the building in terms of ecology, economy, functionality and configuration.

Long-term use of buildings
Durability of the buildings.
Possibility of multiple-use/conversion if existing use is no longer needed.

Durability of construction materials and building components
for extension of the life-span of the buildings and
reduction of maintenance and renovation costs.

Optimisation of building component geometries
for increase of utilisation value and social transparency,
for wider range of uses, better chances for further utilisation and reuse and simpler maintenance/inspection.

Avoidance of composite construction materials and components which are difficult to separate
for better recycling potential and systematic support for the reconditioning, further use and reuse of construction components and materials.

Low contamination levels of the construction components and materials
for easier further use and reuse,
simple disposal of non-usable residual waste and
protection of the soil and groundwater against contamination by hazardous substances.

Controlled demolition if no possibilities for further utilisation exist
for the separation of constituent components and
the greatest possible level of further use and reuse.
(cf. Working Note on Recycling, BMVBW)

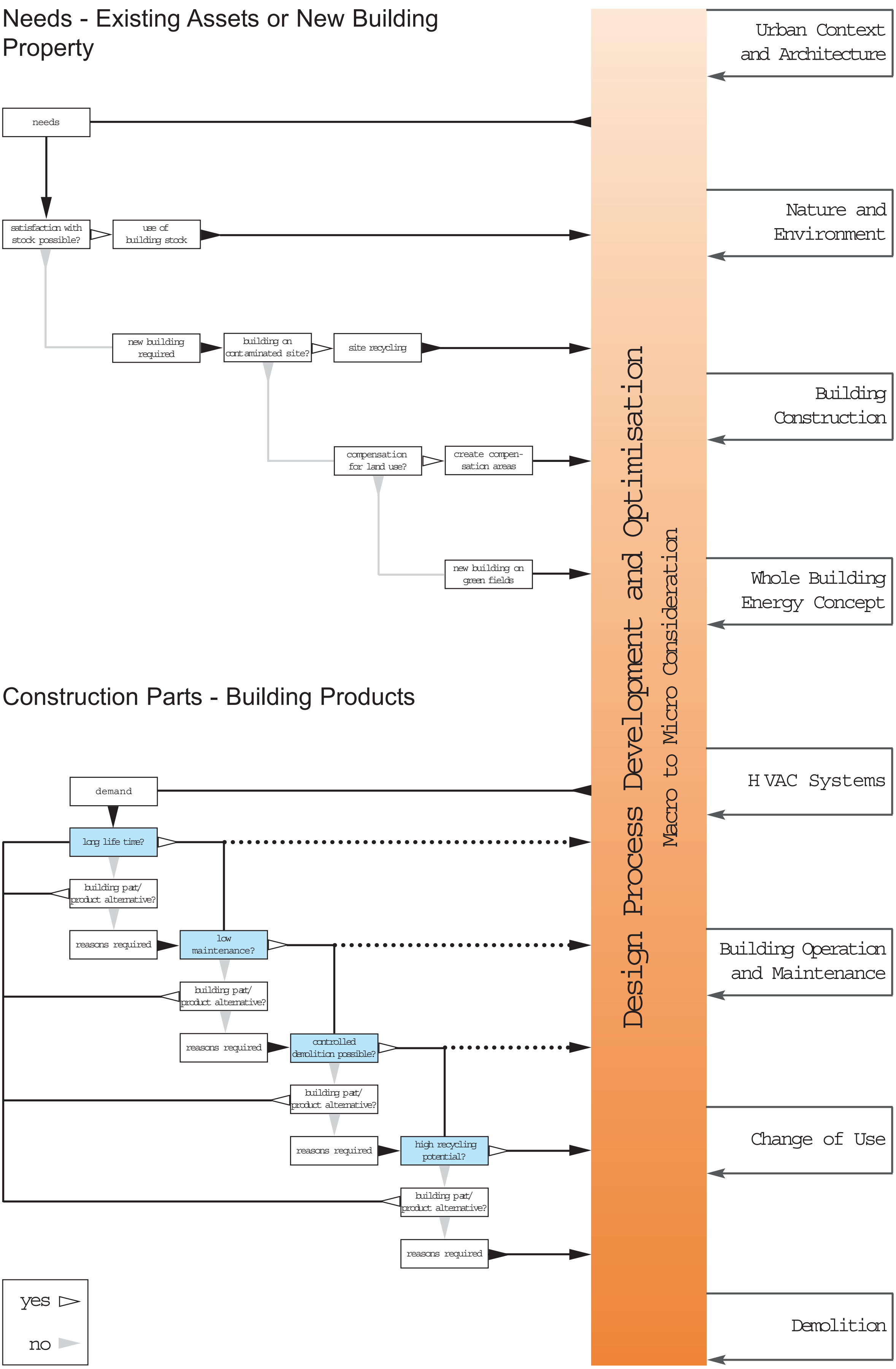

Figure 2: Cascade Model of Planning Principles

3.2 THE DESIGN

When designing buildings and their technical installations, care must be taken to ensure that

- the demands on functionality and design are fulfilled,
- health and comfort are guaranteed during the period of their use,
- costs for energy, operation and maintenance are minimised,
- the building can be operated with only low cleaning costs, or is partially self-cleaning (e.g. roofs and facades),
- the costs for inspection, maintenance and operation are kept at a low level and
- these items can be economically performed whilst also conserving resources and the environment as well as
- generating as little user-dependent traffic flow as possible.

Reduce operational costs and protect the environment

Environmental impact is directly related to operational costs.
The following items involve significant expenditures, as the case-by-case examples from 1998 demonstrate:

- Electricity/Cooling (15 - 40 €/m² HNF·year)
- Cleaning (15 - 35 €/m² HNF·year)
- Inspection and Maintenance (5 - 35 €/m² HNF·year)
- Value-conserving Building Maintenance (5 - 15 €/m² HNF·year)
- Heating (5 - 15 €/m² HNF·year)

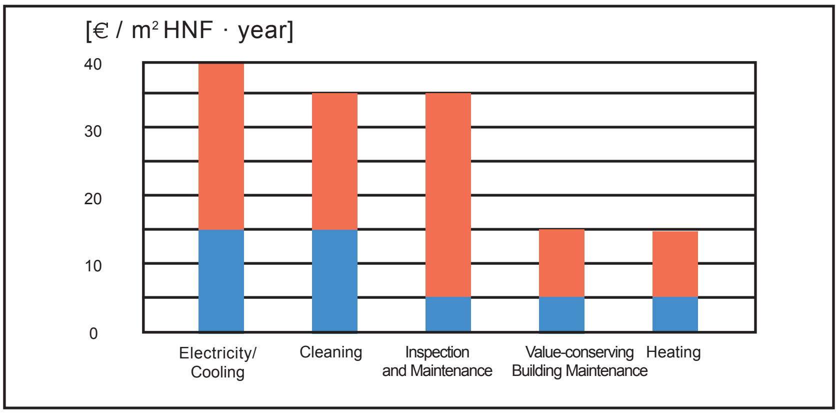

Figure 3: Operational Costs per m² HNF and Year (Examples)

Create a network between architect and design experts

A primary requirement of the architecture and integrated building design is to minimise and optimise the technical installations through the correct choice of geometries and construction products. This can also substantially reduce construction and follow-up costs, and thereby environmental damages. The architect and design experts must therefore work closely together in the design team from the earliest possible moment.

Develop a sustainability concept

By the interdisciplinary co-operation of all participants, a sustainability concept should be developed early on in the project. In this way solutions can be reached which are convincing as much through their functionality as through their positive affect on health, comfort, architecture, urban planning, form, economic efficiency, construction and ecological quality.

SPECIFIC REQUIREMENTS

The design principles described above lead to specific requirements on individual sectors and building trades. For the sake of clarity, they have been compiled in the following appendices.

Appendix 1: Checklist
Appendix 2: Planning principles for the design of buildings and landholdings
Appendix 3: Health protection and comfort
Appendix 4: Energy and building services
Appendix 5: Design principles for outdoor facilities
Appendix 6: Assessment of the sustainability of buildings and landholdings
Appendix 7: Building certification

Explanations for the use of the Appendices :

Appendix 1

Appendix 1 is a brief synopsis of the main requirements in the other appendices. It serves as a checklist for the specific requirements for individual buildings. It provides a handy tool which describes the tasks and checks involved in each step in the planning and decision-making processes.
This checklist (Appendix 1) should be provided to the designers or competition participants for the preliminary design or competition phases. It highlights those requirements which have to be fulfilled in the preliminary or competitive design by means of drawing, written documentation or calculation.

Limiting, guideline and target values are stipulated for usage and operational costs. These cover in particular:

- Construction costs
- Electricity requirement
- Energy requirements for heating/cooling
- Inspection and maintenance costs
- Costs of value-conserving building maintenance
- Cleaning costs
- Water/sewage consumption and costs

All costs are relating to m² HNF and year.
The same applies to later design measures.

Appendix 2

Appendix 2 describes the design requirements in terms of sustainability, beginning with the first planning phase. This appendix analyses in particular the impact of the construction, operational and maintenance phases on the architect's design. Specific requirements for specialist sectors, which are to be fulfilled by the individual design experts, are not discussed here. These issues are the subject of Appendices 4 and 5.

Appendix 3

Given the importance of the requirements for health and comfort, these have priority over the requirements for the building installations and services. They also apply to all of the following requirements relating to specialist disciplines.

Appendix 4

This appendix includes all the main relevant design criteria for the design expert responsible for the building installations and services. However, the energy-related requirements can generally best be met by adopting an integral design approach.

Appendix 5

This discusses the design of outdoor facilities within an integral overall design.

Appendix 6

The ecological and economical assessment of a building covers its entire life-cycle up to demolition. The ecological part is not initially made on a monetary basis. Social and cultural aspects complete the assessment of sustainability.

Appendix 7

The building certification includes important key data on the building. It is of particular relevance to the utilisation phase (facility management) and for documenting the building's history (important for conversion or demolition works).

Explanatory Report/Building Description

According to the RBBau the explanatory report should contain the concepts for a minimisation of utilisation and operational costs for

- Electricity
- Heating
- Cooling
- Cleaning
- Inspection and maintenance
- Value-conserving building maintenance (cascade model)
- Building services (water, sewage, waste)

In the report the total costs, these are the construction costs plus building utilisation costs, should be optimised.

The explanatory report must include reasons for the non-observance or non-achievement of specific requirements which are relevant to the proposed building (Appendix 1).

A concluding overall assessment should list and assess possible alternatives, in particular for the following areas of conflict:

- Investment costs vs. operational costs
- Investment and operational costs vs. external costs and environmental damage
- Conventional vs. innovative construction methods

ECOLOGICAL ASSESSMENT - CONSTRUCTION, OPERATION, USE AND DEMOLITION

Construction, Operation and Use

Energy/ Resource flow management

The ecological assessment is made as described in No. 3 of Appendix 6. As far as it is technically possible and economically justifiable, consideration should be given to all aspects of the required energy and resource flows over the total life of the building. These include production, processing, transport, installation and demolition as well as pollutant emissions, in particular those due to the energy consumed by the building materials and by the use of the building.

This question will require greater attention in the future. The installation and demolition phases themselves are of only minor importance in the ecological assessment on the basis of an ecological balance evaluation "from the cradle to the grave" (after ISO 14040 ff.), which assesses the material flows from the construction of the building through its operation and use up to its demolition. The construction planning of the building sets the general conditions for the ecological, economic and socio-cultural impacts during the utilisation phase of the building.

The operational and utilisation phase, on the other hand, acquires a special significance. This is particularly true when considering a long-term assessment period (50-100 years).

Facilitate consumption monitoring

Hence it is particularly important to monitor the consumption of resources (e.g. energy, water) and operational costs during the utilisation phase. The conditions for efficient building management have to be established as early as the design phase (comparison of design values with actual values for key indicators).

Environmental costs = f (construction + operational costs)

As a rule, the impacts on the environment arising from the construction, operation, utilisation and demolition of a building correlate with its construction and operational costs.

Nowadays the significant factors here are the costs of

- Energy (electricity, heating, cooling)
- Cleaning
- Inspection and maintenance
- Value-conserving building maintenance

There are buildings for which the cumulative operational and utilisation costs exceed the costs of constructing the building after less than 10 years.

An economic optimisation of the total costs (construction costs + building utilisation costs), can be expected to lead to a considerable reduction in the environmental impact of the project. The individual factors should be considered separately when making the ecological assessment.

- **Energy:**

Approximately one third of the annual CO_2 - emissions in Germany are caused by the heating, cooling and lighting of buildings. The consumption of electricity is the main cause of high levels of CO_2 - emissions in the country.

- **Cleaning:**
An important element of cleaning costs is the cost of labour. These costs do not include the consumption of electricity and water, since the cleaning companies use the existing infrastructure. The use of cleaning agents takes on a special significance.

- **Inspection and Maintenance:**
The cost of labour outweighs all others, whilst operating resources and electricity are environmentally relevant.

- **Value-conserving Building Maintenance:**
As in the case of the construction of the building, the material flows should be assessed even if the proportion of the costs due to labour and electricity are greater. As compared to a new construction, reference must be made to the increased use of auxiliary building materials such as adhesives, paint and varnishes (problems of indoor air quality).

Although the scientific investigations and agreements on the comparability of objective ecological balances over the life-cycle of buildings have yet to be completed, the "preliminary ecological assessment" (Appendix 6) still provides an adequate basis for a design aid for sustainable building. If the design of a building is based on the above planning principles, then the following general principle provides a first approximation for the construction, utilisation and operation of a building:

Positive ecological characteristics result in low overall costs

The better a building is assessed from an ecological standpoint, the lower the total costs of the building will be (construction, operation and utilisation costs). Operation and use are particularly important here. Besides considering construction costs, future investment decisions made by public sector clients must therefore place increased importance on the costs of operation and utilisation, and these must be included in the assessment of the project.

Favourable operational and utilisation costs can be achieved as a rule by doing without avoidable and expensive building components and building technology. They can also be achieved in individual cases by using such components and technology in a focussed manner. For many types of buildings, restricting energy consumption (particularly of electricity) and the costs of cleaning, inspection and maintenance can do away with building components and concepts which would otherwise have driven up the costs of construction.

As little technology as possible, just as much as needed

By following the principle "as little technology as possible, just as much as needed", the construction and operational/utilisation costs can be considerably reduced.

Demolition

The demolition and clearance of a building are governed by the requirements for the most extensive and valuable reuse and recycling of materials and the minimisation of the resulting waste. The BMVBW working notes on recycling must be observed here (i.e. the working note on "Avoidance, utilisation and disposal of construction waste in the design and construction of buildings").

The design and tender phases should include a model for the disposal of construction waste. This can be undertaken, for example, by an obligatory interview of the companies on their disposal concepts.

Environmental Pollution

Building pollutes the environment

The construction, operation/use and demolition of buildings all lead to damages to the environment and hence to external costs. The assessment and analysis of need must therefore take first place in the planning principles.

Although difficult to quantify, the medium- to long-term effects of using rural and natural areas as well as exploiting raw materials lead to environmental pollution. Similarly, the emission of pollutants from production, processing, transport, utilisation and disposal is transmitted in various ways through the air, water, soil, building structures, plants, animals and humans. These however, cannot presently be expressed in monetary terms because of difficulties with the methodology.

It is of course possible to estimate and assess environmentally-related pollution in monetary terms for specific sectors (e.g. forest damage reports and structural damage reports from the federal government, insurance company statistics); however, a comprehensive monetary assessment of the consequences for humans and the environment from all the impact factors is currently not feasible.

The environmental effects include storms and floods. Damages to forests and buildings due to pollutants transmitted by air alone cause annual damages in Germany of the order of billions of €.

Reduce energy consumption

The major part of environmental pollution can be traced to the consumption of energy and the nowadays resulting emissions into the atmosphere. Therefore one of the essential objectives of the Sustainable Building of buildings must be to reduce the consumption of energy.

Ecological Assessment

The ecological assessment of buildings during their long life-cycle is a part of the assessment of their sustainability. This also includes an economic and a socio-cultural assessment. Three protection objectives stand at the forefront of the ecological assessment:

- Protection of human health
- Protection of the ecological system
- Protection of resources

All ecological impacts are based on the flows of energy and material. The assessments are therefore based on the estimation or calculation of the extent of these flows. If precise data on the energy and material flows are lacking, then an attempt can be made to limit their relative extent by suitable measures at the source (avoidance strategies). Each assessment is based on system limits, and these must be known. Without this information the assessment is useless.

A basic distinction has to be made between qualitative (descriptive) and quantitative (calculative) methods for the ecological assessment of buildings and landholdings.

Qualitative assessments are easier to conduct than quantitative procedures. The results however often cannot be compared with another or are not accurate enough, due either to different system limitations or to different reference values.

Quantitative assessments on the other hand are associated with considerably higher costs, due especially to the amount of data needed. This makes the implementation of computer-based tools both necessary and sensible.

In early planning phases (competitions etc.) the required input data are not yet available, so that a qualitative process is stipulated for preliminary assessments. As the planning process becomes more and more concrete, this can be converted into a quantitative assessment (see Appendix 6).

5. ECONOMIC EFFICIENCY

Reduction of construction and operational costs

Constructing and using a building both have an effect on the environment. High building utilisation costs are not only closely associated with a high level of environmental impact, but usually with high construction costs as well. Therefore considerable care must be given to reducing construction and operational costs when observing the above principles. Thus, besides the generally well-known design requirements for economic construction (e.g. in accordance with § 7 BHO, RBBau), three areas require increased attention:

- Analysis of the demand in terms of the type and scope of requirements
- Consideration of economic building construction procedures as early as the design stage
- Reduction of operational and utilisation costs, if necessary accepting an increase in construction costs for individual components, as long as § 7 BHO is complied with

6. HEALTH, COMFORT AND SOCIO-CULTURAL ASPECTS

Constructing buildings for people - the social dimension

Buildings in which people spend their time must correspond to the needs of their users and should guarantee a high level of well-being.

The internal and external impact of a federal building reflects the democratic culture. Both, the relationship with citizens and the creation of historical values can be expressed by the impact of the building and this aspect must therefore be considered in the assessment.

Avoid pollution of the indoor air

Health risks resulting from the use of hazardous materials must be reliably excluded. The agreed objective is to create the best possible conditions for people residing and working in the interior areas of the building that are also acceptable from an economic point of view.

Factors that have particular influence on people's well-being and productivity include:

- Building architecture
- Geometry of the building and rooms
- Good design, materials, colour scheme
- Perceived room temperature
- Humidity in the room
- Air quality in the room (contents of the air in the room/hazardous substances)
- External air ventilation/air circulation
- Natural and artificial lighting
- Building acoustics/noise emissions
- Technical installations and furnishing

The physical design parameters, which are defined by the planning of these items, must be determined on the basis of the existing technical specifications (DIN, VDI-regulations, AMEV-guides etc.), whilst taking the requirements of each particular case into account.

The Building Products Act

Demands on the health quality tolerance of building products are listed in the building regulations of the federal states of Germany through the Building Products Act.

The implementation of the Regulation on Building Products

The European Regulation on Building Products, its implementation at a national level and the international and European standardisation and registration of building products, have all led to building products being treated systematically and as a whole with regard to eight requirements.
These are:

- Durability
- Suitability for use
- Mechanical stability
- Fire prevention
- Hygiene, health, environmental protection
- Safety of use
- Sound protection
- Energy conservation, heat conservation

Recognised health risks must be considered in the building product specifications.

Last, but not least: the social dimension, improving the quality of life

Social sustainability covers a multitude of dimensions. The preservation of human health and well-being is an essential component. Many illnesses and restrictions on the quality of life are caused by or aggravated by environmental factors. In terms of the building sector, this affects both the people who live in the buildings and those who construct them. The requirements on health and well-being can be found in Appendix 3.

Building / people relationship

Due to their mostly prominent position and function, public buildings are increasingly a focus of public attention. They are endowed with a model function, which also has a creative component. Forming an important part of our building culture, they reflect how our society sees itself. They are a stable factor with a special responsibility with respect to the relationship between state and citizen. At the same time, if they fulfil their model role, then they are regarded with a special esteem and as a lasting value. Therefore the interests related to preservation of the building, its upkeep and maintenance as a witness of contemporary history, and cautious conformity to its surroundings are all factors of sustainable building that also have to be included in the design together with the general economic and ecological aspects.

Visualise user behaviour

A further component is the introduction of mechanisms to encourage the users of a building to adopt more economical and environment-friendly behaviour by implementing appropriate measures. The ability to visualise (user feedback) one's own consumption (heating energy, electricity, water, etc.) is a suitable means of reducing their use.

7. PROJECT TENDER AND CONSTRUCTION

The ecological principles are anchored in the project tender. The opportunity to submit ancillary offers and special suggestions is intended to encourage alternatives, with the general aim of finding better ways of fulfilling the requirements.

The reuse of building materials and components (e.g. broken concrete, stairs, windows and structural members resulting from the conversion of a building, the demolition of another structure or from a reusable materials exchange) as well as the utilisation of recycled building materials must be clearly set out as appropriate items in the specifications. In this context, the long-term economic impacts over the entire life-cycle of the project should also be taken into consideration.

When examining the ancillary offers, attention is given to ensure that the ecological criteria are complied with as specified in the project tender documents.

The construction supervision must ensure that the tendered services (building materials and procedures) are used or applied as specified.

Environment-friendly construction site facilities and operations are to be identified separately in the tender documents. They must be monitored during the construction phase.

OPERATION / USE / BUILDING MAINTENANCE 8.

Constant checks on performance and consumption, educating and informing the users and operators on all the effects of sustainability and frequent operational and utilisation analyses will help reduce costs during the utilisation phase. This requires an adequate number of monitoring facilities.

Regular inspections will have to be conducted to establish the required level of building maintenance, and smaller construction measures will have to be prepared. They can be used as an opportunity to analyse the operation and the use of the building as defined by the planning, operational and utilisation requirements referred to earlier. This should be done in close agreement with the client and the user. Measures for improving the operation and utilisation of the building should be mutually defined and agreed to.

QUALITY ASSURANCE 9.

The implementation of the requirements for sustainable building must be guaranteed over the entire life-cycle of a building project.

It should be ensured that the jury for the competition process includes at least one technical assessor, who is also competent in the areas of operation/energy/ecology.

Demonstrable experience in the ecological and economic sectors are important characteristics of a suitable project management team.

Monitoring during the utilisation phase is to be seen as part of a required comparison process (benchmarking).

The continuity of expert support throughout the life cycle should be guaranteed by suitable organisational measures.

By means of modern, computer-based management of inventory and consumption data, the buildings and landholdings can be compared with each other. The aim here is to improve quality, which as a rule implies lower costs.

10. HOW TO USE THE GUIDELINE

The principles of the guideline apply to the entire life-cycle of a project. Nevertheless the focal point of the specific application of this guideline is on the relevant planning phases as set out in the HOAI.

The first step is to advise the user of the planning principles with respect to the development programme to be implemented. The clear objective is to avoid having to construct a new building by optimising the use of existing assets. Here, aspects not related to construction, such as the generation of traffic flows and the minimisation of space requirements, are also to be considered.

Once a well-founded decision in favour of a building project has been reached, in each of the subsequent design phases the following factors must be taken to varying degrees into consideration:

- Ecology
- Economy
- Building culture/social effects

Each of these factors should be assessed separately for a utilisation period of 50-100 years.

The administrative procedures for the evaluation of the economic feasibility of the project, including building utilisation costs, should be established in accordance with § 7 BHO (e.g. capital value method). The cost basis and the comparability of buildings with each other is established by the value E/m² HNF and complimented by E/m² BGF.

The precise quantification of the material flows and primary energy contents of the building structure must wait until a suitable method for computer-based analysis becomes available.

The planning objectives are determined on the basis of the checklist (Appendix 1). The overall assessment in each planning phase is conducted in accordance with Appendix 6.

The following persons contributed to the preparation of this guideline:

Mr. Bayerl	BMVBW (Federal Ministry of Transport, Building and Housing), Berlin
Mr. Dr. Böhm	Fraunhofer Institute, Institute for System Theory and Innovation Research (ISI), Karlsruhe
Mr. Bong	BMVBW
Mr. Cremer	BMVBW
Mr. Dr. Eggers	UBA (Federal Department of the Environment and Natural Resources), Berlin
Mr. Eiermann	University of Karlsruhe, Institute for Industrial Building Production (ifib)
Mr. Gleue	BMVBW
Mr. Heckrodt	Energy-Saving-Union of Leinefelde
Mr. Dr. Heinrich	Institute for the Preservation and Modernisation of Buildings e.V. at the Technical University of Berlin (IEMB)
Mr. Kerz	IEMB
Mr. Prof. Dr. Kohler	ifib
Mr. Lohr	Office for Energy-saving Construction, Cologne
Mr. Dr. Löhnert	solidar Planning Workshop, Berlin
Mr. Oldenburg	Otterpohl-Water Concepts, Lübeck
Mr. Ornth	BMVBW
Mr. Dr. Pieplow	Federal Ministry of Environment, Natural Protection and Reactor Safety (BMU), Berlin
Mr. Prof. Dr. Polster	IEMB
Mr. Rathert	BMVBW
Mr. Prof. Dr. Richter	Technical University of Dresden
Mr. Rietz	IEMB
Mr. Dr. Römmling	IEMB
Ms. Sahler	BMU
Mr. Schafhausen	BMU
Mr. Schäl	UBA
Mr. Prof. Dr. Stolpe	University of Bochum
Mr. Strauß	Architect, Cologne
Mr. Dr. Vogdt	IEMB
Ms. Wagener-Lohse	UBA

Appendix 1 CHECKLIST

0. GENERAL

This checklist forms the basis of the planning process. It is meant to ensure that all the criteria relevant to the theme of sustainability are given due consideration. It is largely identical with Appendix 6, which covers the assessment of sustainability.

Appendix 1 summarises the main requirements from the other Appendices. It is meant to serve as a checklist on the specific requirements for individual projects. It provides an easy-to-use means of checking each planning and decision stage.

The checklist (Appendix 1) should be given to the planner and competition participants for their use in the preliminary design and competition phases of a project. It highlights those points for which the fulfilment of general or specific requirements must be demonstrated in text form or by means of drawings and calculations with the preliminary design / competition submissions.

The checklist gives limiting, guideline and target values for utilisation and operational costs. The same apply to the later planning stages.

1. ECOLOGY

Criteria	Notes	Target enter specific target	Remarks fulfilled/not fulfilled
1. Realisation of building requirement (analysis of building requirement)			
1.1 Building requirement	Appendix 2		
1.2 Continuing use of existing buildings	Appendix 2		
2. Protective use of building land and natural resources			
2.1 Use/conversion of derelict industrial land/ military facilities/gaps between buildings	Appendix 2		
2.2 Surface sealing	Appendix 5		
2.3 Area required for transport installations	Appendix 2+5		
2.4 Use of excavated soil within the landholding (mass balance)	Appendix 2		
2.5 Integration into the urban environment or into the landscape	Appendix 2+5		
2.6 Use/protection of groundwater	Appendix 5		
2.7 Use of rainwater within the landholding	Appendix 5		
2.8 Preservation of areas of unspoiled nature and of ecological structures, improvement of the biodiversity of undeveloped ground (compensation)	Appendix 5		

2.9	Remediation of contaminated soil	Appendix 5		
2.10	Constraints for protection against emissions			
	- greenhouse gases			
	- air pollutants			
	- noise			
3.	**High level of durability and multipurpose-functionality of the building, problem-free demolition**			
3.1	Durability of the building	Appendix 2+6		
3.2	Usability of the building	Appendix 2		
3.3	Demolition possibilities of the building	Appendix 2		
3.4	Reuse of building components / materials	Appendix 2		
	- load-bearing structure			
	- exterior walls			
	- ceilings			
	- interior walls			
	- roof construction			
	- building services			
	-			
3.5	Recycling of building components and materials	Appendix 2		
3.6	Modular construction / use of prefabricated components	Appendix 2		
4.	**Use of health- and environment-friendly construction and fitting out materials**			
4.1	Use of low-emission products	Appendix 3		
4.2	Special requirements	Appendix 3		
5.	**Costs during use of the building**			
5.1	**Rational use of energy**			
5.1.1	Energy-friendly construction method	Appendix 2+4		
	- compact construction method			
	- involve the building substance as a reservoir of heat / cold			
	- proportion of rooms located in the interior			
	- location of rooms with RLT to noisy streets			
	- pipe network for utilities services to lavatories and sanitary facilities, kitchens etc.			

5.1.2 Low energy housing standard / achievement of a high level of structural heat insulation	Appendix 4		
5.1.3 Ventilation of residential areas/natural ventilation of the buildings	Appendix 2+4		
5.1.4 Passive use of solar energy	Appendix 2+4		
5.1.5 Use of daylight	Appendix 2+3		
5.1.6 Natural insulation against summertime heat/avoidance of mechanical cooling	Appendix 2+4		
5.1.7 Conditions for the active use of environment-friendly sources of energy	Appendix 2+4		
5.1.8 Integrated energy supply concept	Appendix 4		
5.1.9 Connection to the local public transport system	Appendix 2		
5.2 Minimisation of other costs during the utilisation phase			
5.2.1 Cleaning costs	Appendix 2+6		
5.2.2 Water consumption	Appendix 4+5		
5.2.3 Maintenance/inspection	Appendix 6		
5.2.4 Sewage and waste	Appendix 2+4+5		
6. Building-specific requirements (enter details)			

ECONOMY

Criteria	Unit	Target	Remarks
HNF	m^2		
BGF	m^2		
Building Project Costs based on DIN 276	€		
100 Property			
200 Preparation and development			
300 Building-construction			
400 Building-technical installations			
500 Outdoor facilities			
600 Furnishings and artworks			
700 Ancillary building expenses			
Investment Subtotal			
Expenditures - Utilisation Phase	**€ / (m^2 HNF · a)**		
Cleaning of the building			
Water/sewage			
Heating			
Cooling			
Electricity			
Service, maintenance, inspection			
Miscellaneous			
Building maintenance			
Utilisation Subtotal			

3. SOCIO-CULTURAL ASPECTS

Criteria		Target	Remarks
Special requirements which go beyond the normal standard for integration into the surroundings, form (external impact) and the relationship between interior areas and people (interior impact) etc. These aspects also include freedom from barriers and the protection of historic monuments etc.			

PLANNING PRINCIPLES FOR THE DESIGN OF BUILDINGS AND LANDHOLDINGS

CONTENTS

0. GENERAL

The Appendix "Planning Principles for the Design of Buildings and Landholdings" sets out the basic requirements that must at a minimum be taken into consideration for a design aimed at the concept of sustainability.

Appendix 2 is directed primarily towards architects who can use their design to exert a significant influence on the implementation of the principles of sustainability.

The technical design specialists must comply with the specific requirements which derive from the general requirements referred to in the following. The specific requirements are the subject of Appendices 3, 4 and 5.

The assessment of economic feasibility should consider not only the overall economic feasibility of the project but also that of each single design step, in accordance with § 7 BHO.

1. BUILDING AND SPACE REQUIREMENTS

Review space requirements

The area and space requirements established by the client should be critically reviewed in terms of their real need and appropriateness, and in particular for any likely over-provision. The assessment of needs should also include the proposed standard of fittings and equipment. This also applies to the relevant guidelines and publications. Attention is drawn to the health and safety protection regulations when working with computer displays (Regulation on workplaces with computer displays).

Ideal area and space relationships for administration buildings are:

- NF / BGF $> 0{,}6$
- HNF / NF $> 0{,}8$ and
- BRI / BGF $\approx 3{,}0$

Use of existing buildings

Before a decision can be made on a new building project, it must be conclusively demonstrated that the spatial requirement cannot be covered by existing buildings - even after allowing for optimising the building occupancy. This step should include consideration of the possibilities offered by change of use, building conversion and building renovation.

Minimising space demand

The demand for space should be minimised. The building design should be as amenable as possible for subsequent uses.

URBAN DEVELOPMENT AND REGIONAL PLANNING

Orientation towards urban planning objectives

In addition to the legal constraints, the design should be oriented to the urban development planning concepts set out by the local authority, provided that for each case, after considering other design requirements for the project, this is possible and sensible.

Limiting demand for space

Two of the objectives of a sustainable urban development policy - when seen from the ecological point of view - are the economical and conservational use of building land, and the minimisation of spatial requirements for the development. The project design should include consideration as to how far the framework of planning laws and building regulations (GFZ/GRZ) should be utilised to the maximum for the conservation of resources.

Area recycling

It may also be possible for example to put derelict industrial land, areas formerly used for military purposes and other underused areas to new purposes or to fill in gaps between existing buildings.

Conservation of natural resources

Attention is drawn to the legal requirements for the protection of the environment and natural resources. Existing stands of trees and hedges should be preserved wherever possible.

Integration into the urban environment

An important aspect in the project planning is the integration of new projects into the existing urban environment. From the ecological point of view the alignment of the building structures with the typical local wind directions play a role, since they help ensure a natural ventilation of the local area.

Minimising space for transport facilities

The use of existing infrastructure often offers advantages over the construction of new infrastructure. Sites with good access to local public transport services are as a rule to be preferred. Traffic flows should be minimised. The area within the landholdings set aside for transport facilities should be limited in size and wherever possible should be given permeable surfaces.

Compensatory measures

Planning requirements for compensatory measures determined in accordance with the laws on the protection of natural resources are to be implemented. Provided that the economic feasibility of the project is assured, other measures can also be considered, such as the planting of roof areas and facades. In the planning of open spaces, native vegetation and vegetation appropriate to the location are to be preferred as design elements.

3. BUILDING DESIGN

3.1 Concept of Sustainability

The early involvement of the various design experts will support the goal-oriented development of an agreed concept of sustainability. The individual components of the concept are to be selected in accordance with the various aims of the conservation objectives.

3.2 Additional Requirements on the Design

Besides the classical requirements for a good and coordinated design, the following aspects must also be taken into consideration:

- Economical use of renewable energy should be taken into account during the earliest design phases.
- When considering the orientation and inclination of the outer surfaces of buildings, consideration should be given to the use or planned later use of solar energy.
- For energy-saving reasons, compact building structures are to be favoured.

The aspects of "barrier-free construction" as defined in DIN 18024 and 18025 must be considered in close agreement with the user. Ramps at the entrance area can be integrated as creative design elements into the overall concept. Elevators, doors and/or location of switches and electronic push-buttons may be arranged in a manner which does not affect cost and which is suited for use by disabled persons.
The design should be based on the BMBVW guideline on fire protection.

Administration buildings, with the exception of canteens and accommodation facilities, need not to be provided with a hot water supply system.

3.3 Construction

Durability

The entire construction should be designed for a long lifetime by, for example, the use of building components which are long-lasting and which need little or no maintenance. Low maintenance costs are to be aimed for.

Service loads

Service loads and the organisation of the ground plan should be optimised between economic efficiency and the requirements of multiple use.

Modular building construction is to be preferred.

Optimised construction

Load-bearing structures should be optimised in terms of economic efficiency, minimum use of materials, sound protection and protection against summer heat.

Composite constructions

As a rule, pre-fabricated components increase quality and support economic efficiency and environmental protection. Composite construction techniques should only be used where the units can be easily separated.

The use and layout of rooms should be harmonised (e.g. with respect to temperature and noise). Another objective is the use of natural lighting.

Use of interior rooms and long rooms extending inwards should be avoided. The possibility of using directed light should also be considered.

The proportion of windows on facades should be optimised in terms of natural light and energy loss/gain, in particular with regard to the need for cooling in summer.

The possibility should be considered of how easily-accessible, adaptable and upgradable service channels (for electricity, communication, water etc.) can most economically be arranged.

Energy Requirements for Building Quality and Technical Building Installations

The level of later energy consumption in a building is considerably influenced by the architectural design. This particularly applies to the cooling requirement and the energy required for lighting, any mechanical ventilation which may be necessary and the annual heating power requirement.

Thermal bridges should be avoided.

Glass surfaces are as a rule not favourable in terms of either energy consumption or economic efficiency.

Effective heat protection
Appendix 4

Even today, the requirements of the future Energy Conservation Act should be applied when designing the heat insulation for a building. Heat insulation for summer months can be ensured by effective shading measures. Temperature balance should preferably be ensured by night-time ventilation. However this should take into consideration the requirements of building security and fire protection.

Importance should also be given to airtight conditions.

The possibilities and limitations of manual ventilation shall be investigated.

Heating surfaces should not be cladded.

Use of efficient mechanical services in a building can reduce its electricity demand.

Comparison of various systems

Where different and competitive systems for mechanical services are available, for which the relative advantages and disadvantages cannot be identified without detailed investigation, then comparisons between the systems should be carried out.

The following steps are to be taken in order to solve the technical aspects:

- Comparison of systems in terms of business efficiency (investment, annual costs according to the annuity process)
- Energy and annual balance sheets
- Recommendation of a preferred solution

Comply with AMEV

The design of building services (heating, ventilation and air-conditioning systems, sanitary facilities, electrical installations, lighting etc.) should observe i.a. the recommendations of the government and local authorities' "Mechanical and Electrical Engineering Working Group (AMEV)".

3.5 Building Components and Auxiliary Materials

Health quality

The selection of building materials and components in the design phase should be in accordance with their application, as well as the relevant specifications provided in the standard or otherwise approved procedures and classifications.

When selecting building and other materials, the environmental logo "Blue Angel" can be a useful guide. The health quality, in particular of the auxiliary building materials, is of great importance. Where other properties are similar, the use of recyclable materials is favoured.

Building certification
Appendix 7

The materials used should be recorded in the building certification.

3.6 Soil and Groundwater

Comply with working note on contaminated sites

Contaminated sites are not necessarily excluded from any subsequent use and they should therefore be included in the planning. Reference is made here to the working note on contaminated sites. The accumulation of soil waste must be kept to a minimum. A reduction in the amount of unavoidable soil waste can often be achieved by compensatory measures on the landholding or through other recycling processes.

Minimal surface sealing
Appendix 5

With respect to water economy, the environment-friendly approach of using rainwater was developed as an alternative to the traditional removal and drainage of rainwater. This makes it possible to avoid the disadvantages of conventional drainage systems but without restricting their advantages e.g. the provision of a high level of drainage comfort. A basic principle of this concept is the decentralised use or infiltration of rainwater - which combine important small-scale effects such as storage, flow reduction and the renewal of groundwater. The input and accumulation of hazardous substances which can result from the infiltration measures must be given serious attention.

3.7 Green Spaces

Outdoor facilities

Open spaces should be designed, built and maintained to support the natural ecosystem. Young plants of types typical of the locality are particularly suitable here, which generally require a low level of care. It is recommended that the planting of traffic facilities is designed accordingly.

Planting of roof areas

Where economically feasible, the planting of roof areas and of suitable facades should be included in the overall planning of the project and designed to keep the maintenance requirements as low as possible.

3.8 Water/Sewage

Reduction of water consumption

Consumption of water in administration buildings should be reduced as much as possible by using water-conserving sanitary technologies. Warm water facilities should be limited to kitchens and accommodation facilities.

Foul water and rainwater should as far as possible be collected and drained in separate systems.

Use of rainwater

As far as economically feasible, rainwater should be used as industrial water (e.g. for irrigating green areas). At the same time the possibility of allowing for rainwater infiltration should be investigated, bearing in mind however the limitations of the specific location and by environmental considerations. In well-founded individual cases, rainwater and "grey" water may be used as industrial water in separate distribution systems if the system is well controlled in technical and hygienic terms and where this is justified by ecological and economic considerations.

Minimise pipe network

Supply and drainage systems should be laid together, the aim being to reduce network lengths and losses.

Concentration of sanitary facilities within the building is favoured.

No pumping systems
Appendix 4

Pumping systems should be avoided.

3.9 Cleaning

Limit cleaning requirements

Basically, the building shall be designed so that the cleaning effort is kept as low as possible.

Provide smooth surfaces

Use of smooth surfaces and largely uniform materials (floor covering) is to be preferred. The use of glass materials leads to higher cleaning costs.

Free of obstructions

The design must facilitate the use of mechanical methods of cleaning. Inaccessible corners, niches, dead areas, spaces, pillars in corridors and rooms, as well as features which require use of expensive lifting equipment are to be avoided. Stairways, for example, should be designed with lateral waterproofing or gutters. Supports for bannisters and head railings should be fixed to the outside edges of the stairs rather than on the stair treads themselves - for easier cleaning.

Sanitary objects, cleaning rooms, water taps and sockets are to be sited and arranged with regard to an optimal cleaning process.

Self-cleaning facades

Self-cleaning facades are favoured.

Establish cleaning concept

A cleaning concept is to be established to enable the design to be assessed and analysed in terms of building cleaning processes.

4. OPERATION

The building administration has to take measures to ensure a continuous monitoring of the consumption of energy and materials, and should help the user or the operator to minimise these by the use of appropriate notices and advice.

Visualisation (monitoring) of the consumption of materials is to be aimed for.

HEALTH PROTECTION AND COMFORT

CONTENTS

0. GENERAL

Due to the importance of the requirements for health and comfort, these are given precedence over the requirements for the technical building services. They also apply to all the technical requirements referred to in the following.

The assessment of economic feasibility must not only cover the overall economic feasibility of the project; it must also consider each single step in the design process in accordance with § 7 BHO.

1. CONSTRUCTING BUILDINGS FOR PEOPLE

People's health and comfort are mainly determined by the following building parameters:

- Indoor air quality
- Operational room temperature
- Room humidity
- Volumetric open air current
- Wind speed
- Lighting (natural and artificial)
- Building acoustic/noise immission
- Perceived aesthetics
- Materials, colour

2. THERMAL COMFORT

Guarantee comfort

In order to ensure the thermal comfort of new federal buildings, the following generally recognised regulations on the technology are to be observed:

- Recommendations of DIN 1946-2 [3-1],
- The notes in the "Paperback on Heating and Air Conditioning" [3-2],
- E DIN 33403-4 [3-3],
- The AMEV notes [3-4],
- Directive on Places of Work [3-5]

In addition attention is drawn to ISO 7730 [3-6] and VDI 6022 [3-7].

Room humidity requirements

DIN 1946-2 [3-1] applies to room humidity.

Air circulation speed requirements

DIN 1946-2 [3-1] applies to air circulation speed until the entry into force of CEN/TC 156/WG 2 N 230 [3-10].

Verification Procedures:

Verification of comfort during summer periods

Verification procedures are only necessary for the assessment of comfort during summer periods.

The verification that the incident sunlight values are below threshold values must be established according to DIN 4108-2 [3-9].

Note: If the maximum value of incident sunlight permitted by DIN 4108-2 [3-9] is observed, then it may be assumed that the threshold room temperatures during summer periods will be exceeded for a maximum of 10% of the use-time.

Where the level of incident sunlight is exceeded, a thermal room simulation is to be carried out using an approved procedure.

3. INDOOR AIR QUALITY

3.1 General

Hazardous substances in the indoor air

Immissions in the outside air are regulated and restricted by numerous laws and regulations, in particular by the Federal Immission Control Law (BImSchG) and its directives, and by the TA Luft (Technical Instructions on Air Quality). Conversely hardly any legal regulations exist for indoor air quality. Exceptions are working areas in which air pollution may be caused by technical production processes. These are restricted by provisions of industrial law.

Sources of emission

A large number of pollutants from different sources may be present in interior rooms. These may be partly carried in by the outside air (especially those arising from vehicle exhausts); or they may come from sources in the interior rooms. Table 3.1 provides a list of possible interior room pollutants which may be caused by building products and equipment. The table also lists the sources of these pollutants.

No.	Class of Substance	Source (building products and equipment)
1	Dusts	Abrasion of floors, in part insulating materials containing softening agents; processing of building products
2	Carbon monoxide	Defective or poorly ventilated heating equipment
3	Radon	Subsoil
4	Formaldehyde (HCHO)	Wooden materials, acid-hardening varnishes
5	Volatile organic compounds including	Products containing solvents, such as paint and varnishes, floor adhesives, carpets
	● alkanes	
	● aromatic compounds	
	● aldehydes (o. HCHO), ketones	
	● ester	
	● alcohols	
	● terpenes	especially the so-called “biocolors” wooden materials
	● glycols	
	● chlorinated hydrocarbons	Paint stripper
6	Softening agents	PVC-floors, PVC-wallpapers
7	Biocides	Wood preservative, pot conserver
8	Polycyclic aromatic hydrocarbons (PAH)	Screed topping, tar-based floor adhesives

Table 3.1: Exemplary List

A number of substances such as asbestos, pentachlorophenol and poly-chlorinated biphenyles, have already been identified in the GefStoffV and are therefore no longer in use.

Insufficient knowledge of the toxicology of many substances as well as the different ways they are used [3-11], [3-12], make it difficult to issue design guidelines for federal building measures.

Use of low-emission building materials, auxiliary building materials and fittings

Particular attention must therefore be paid to the possibility of hazardous emissions arising from building materials, auxiliary building materials and fittings used in interior rooms.

3.2 Assessment of Indoor Air Pollutants

At present, assessment scales are available for only a few of the numerous hazardous substances which occur in interior rooms.

The following table lists guideline values and provides orientation for the assessment of indoor air pollutants.

Guideline values (GV) proposed by the Ad-hoc Working Group IRK/AOLG[1)]

Substance	GV II (mg/m^3)[2)]	GV I (mg/m^3)[3)]	Source
Toluene	3	0,3	Sagunski 1996 [3-13]
Nitrogen dioxide	0,35 (1/2 h) 0,06 (1 week)	-	Englert 1998 [3-14]
Carbon monoxide	60 (1/2) 15 (8 h)	6 (1/2) 1,5 (8 h)	Englert 1997 [3-15]
Pentachlorophenol	1 $\mu g/m^3$	0,1 $\mu g/m^3$	Federal Department of Environment and Natural Resources 1997 [3-16]
Dichloromethane	2 (24 h)	0,2	Witten et al. 1997 [3-17]
Styrol	0,3	0,03	Sagunski 1998 [3-18]
Mercury (metallic Hg-vapour)	0,35 $\mu g/m^3$	0,035 $\mu g/m^3$	Link 1999 [3-19]
TVOC	see text		Seifert 1999 [3-20]

Table 3.2: Guideline Values for Indoor Air (Status: Summer 1999); TVOC = Total Volatile Organic Compounds

2) Immediate measures to be taken where values are exceeded

3) Target value for remedial works

Total Volatile Organic Compounds (TVOC)

TVOC-concentrations between 10 and 25 mg/m^3 are at most permitted only temporarily. In rooms where people are expected to remain for longer periods of time, the long term TVOC values should not exceed 1-3 mg/m^3. As a long-term average, TVOC-concentrations should be about, and if possible less than, 0.2 - 0.3 mg/m^3.

Sources [3-21 to 3-23] should also be referred to.

Guideline Values independent from the IRK/AOLG

Formaldehyde

In 1977 the Federal Department of Health (BGA) recommended a value of 0.1 ppm (0,12 mg/m^3) for interior rooms. This value is reflected in the regulation on the prohibition of chemicals dated 14.10.1993 (Appendix to paragraph 1, section 3) as the equilibrium concentration in the air of a test room - the regulation refers here to coated and non-coated wooden materials (chipboard, tabletop, veneerboard and fibreboard).

1) Indoor Air Hygiene Commission (IRK) of the Federal Department of Environment and Natural Resources Working Committee of the Superior State Health Administrations (AOLG)

Carbon Dioxide (CO_2)

The amount of CO_2 should not exceed 0.15 %. It is recommended as a hygienic guideline value for indoor air (for seated or light activity in rooms with ventilation and air-conditioning systems). In principle, the "old", traditional Pettenkofer Number (0.10 %) may also be used a basis for evaluation.

Radon

At the moment, no common obligatory value for Radon is proposed. The question of permissible concentrations of Radon for the interiors of buildings is presently being discussed in a working team of the project group "Harmful Substances" at the ARGEBAU.

Volatile Halogenated Hydrocarbons

For rooms which border on operating rooms of chemical cleaning facilities, the second directive on BImschG sets a limiting value of 0.1 mg/m^3 tetrachloroethene (perchloroethylene).

Polychlorinated Biphenyles (PCB)

The values recommended by the Federal Department of Health (BGA) in 1990 were included in the ARGEBAU guidelines issued in 1995. They are also part of the planning law and building regulations of individual federal states such as Hessen and Berlin, which have included these guidelines in their tender procedures. Indoor air concentrations of < 300 ng/m^3 are considered to be tolerable long-term levels.

Where indoor air concentrations between 300 ng/m^3 and 3000 ng/m^3 occur, the sources are to be traced and where reasonable these are to be removed or at least attempts are to be made to reduce the level of PCB-concentrations to a target value of 300 ng/m^3.

Where PCB-concentrations > 3000 ng/m^3 occur control analyses are to be carried out immediately. For values > 3000 ng/m^3, measures are to be implemented without delay. The corrective measures must be suitable to drastically reduce the PCB-accumulation in the affected rooms.

The values of PCB for which action is required are contained in the regulation on the assessment and treatment of PCB-contaminated building materials and components [3-21].

3.3 Requirements and Verification Procedures

Requirements

Exclude air pollution in indoor areas to the greatest possible extent

Use of low-emission building materials

Buildings should in principle be so constructed that any impairment of the indoor air quality caused by air pollutants can largely be excluded. Since emissions from building products and installations considerably affect the indoor air quality, wherever possible only low-emission products and materials should be used.

It may be assumed here that permitted building products in the above sense are not detrimental to health.

Verification Procedures

Measurements are to be carried out where there is cause to suspect a danger to health

Where indoor air pollution caused by chemical substances is either suspected or present, the indoor air should be tested in the affected buildings. The purpose is to determine in qualitative and quantitative terms the exact extent of pollution, and to initiate possible steps to minimise it. A special case for indoor air testing arises in cases which call for the identification of floating dust and the substances it contains.

Determination of emission sources by material tests

Investigations on the materials only provide limited information about the exposure of affected buildings. However, any decision on whether to carry out remedial and maintenance measures (and if so, which ones) should always include the results of tests on building materials and substances, particularly in order to reliably identify the sources of the emissions [3-23].

Volumetric Open Air Current

Requirements:

Limitation of open air rates

If the required volumetric open air current cannot be calculated from the unavoidable content of hazardous materials, then the minimum open air rates of Table 3.3 DIN 1946-2 [3-1] apply.

Type of Room	Example	Open Air Rate person-dependent $m^3/(h \bullet Pers.)$	 space-dependent $m^3/(h \bullet m^2)$
Working areas	Single person office	40	4
	Open plan office	60	6
Meeting rooms	Conference room	20	10 to 20

Table 3.3: Minimum Open Air Rates according to DIN 1946-2 (Excerpt)

From the energy-related point of view, in federal building projects the person-dependent open air rates are to be aimed for.

For open-plan offices and conference rooms the required rates of open air should be based on the space distribution plan and occupation levels. The rates of open air are to be compared for both the

- person-dependent and
- space-dependent

factors. The lower value is the decisive value.

The VDI 6022 [3-7] standards for offices and meeting rooms are also to be observed.

In housing projects, ventilation is to be provided which satisfies the requirements for energy and hygiene.

Verification Procedure

A list of person-dependent and space-dependent open air rates, classified by type of room, is to be submitted.

4. LIGHTING

Lighting to be provided as much as possible by daylight

Lighting is a relevant environmental factor which considerably affects people's comfort and visualising abilities. Daylight is to be preferred to artificial lighting since it does not require the additional use of energy and because people find it more pleasant. In special cases, daylight calculations should be carried out.

To ensure perfect lighting by means of daylight, daylight openings (e.g. windows and skylights) should produce a pleasant level of brightness and also allow an adequate visual contact between interior and exterior areas.

Adequate amount of daylight on working surfaces

Working areas whose dimensions correspond to the size of living rooms should show an average level of daylight on the working surfaces of 0.9 % (see [3-28]).

The required range of visual contact should correspond to an area of 1.25 m^2 for a room depth of up to 5.0 m and to an area of 1.5 m^2 for a room depth of more than 5.0 m (see the Regulation on Places of Work ASR 7/1 [3-29]).

Optimisation of areas with glass surfaces in the facades

Note: With the increasing proportion of glass surfaces in building facades, the heat input during summer periods also generally increases. This can lead to an increased cooling requirement. The proportion of glass surfaces is to be optimised in terms of the use of daylight, the use of passive solar energy and the avoidance of mechanical cooling. Possibilities of "redirecting light" should be fully applied.

Lighting Requirements :

Sufficient level of illumination in accordance with the requirements

Specifications of the required room illumination for different working activities are laid down in the regulations specified in [3-24] to [3-33].

For federal buildings, the layout of artificial light for the illumination of interior rooms is to be based on DIN 5035 [3-28] and on the AMEV regulation "Lighting 92" [3-24] and its successors.

Zone	Rated Illumination Strength
Office rooms for normal administrative activities	300 lx at the workplace 500 lx
Board room, meeting room, conference hall	300 lx
Corridors	50 lx
Stairways	100 lx

Table 3.4: Illumination Requirements

The following points (based on [3-28]) are recommended to help reduce effects of direct glare and reflected glare:

Avoidance of glare

- Light density variations between workplaces and their surrounding areas, maximum 3:1.
- Level of reflection:
  ceiling = 0.7,
  walls = 0.5,
  floor = 0.2,
  surfaces of worktops and tables 0,2 bis 0,5.
- Constant of illumination
  $g_1 = E_{min}$: E of approximately 1:1.5 for horizontally used areas in the room and in parts of the room where specific activities are carried out.

Prevention of eye stress

Limited variations of light density between the workplace and the surrounding area prevent eye stress and consequently also quick exhaustion or fatigue. For general lighting, lamps should be distributed evenly throughout the room. An arrangement of lights parallel to the line of the window is of advantage here [3-28].

Work-stations are to be arranged so that lighting or lighted surfaces will not produce a glare, and so that reflections onto the monitor will be avoided as much as possible [3-32]. The selected lighting must be compatible with the type of room and with the visual activity or work activity to be carried out there [3-33]. Windows which are subject to a glaring effect, must be provided with an adjustable antiglare screen. This will allow the entry of daylight to be reduced which in return enables a reduction of daylight incidence. PC-workstation regulations also apply here.

The following average light intensities within a radiation angle ranging from 65° to 85° are not to be exceeded:

Criteria	Limiting values			
Computer screen surface	non-treated	non-treated	nonreflecting	nonreflecting
Software	negative display	positive display	negative display	positive display
Limiting value of light intensity	200 cd/m^2	500 cd/m^2	500 cd/m^2	1000 cd/m^2

Table 3.5: Limiting Values of Light Intensity at Places of Work
DIN-Draft EN 12464 (October 1998) [3-32]

Verification Procedure :

Use of computer-based methods for optimising lighting installations

Lighting design should be supported and optimised by the use of recognised computer-based calculations. These methods enable the calculation and graphic display of light distribution in a room and on working surfaces in it, and take into consideration the selected lamps and lights, their arrangement in the room, their geometry and degree of reflection.

5. SOUND PROTECTION

Protection from unreasonable noise pollution

The standards of sound protection in buildings, as laid down under public law, guarantee the protection of occupants of these buildings from unreasonable disturbances. The planning principles which apply are set out in the following: DIN 4109 "Sound protection in buildings, requirements and verification" [3-34] which was introduced as a technical building regulation, VDI 4100 [3-35] for residential buildings and VDI 2569 [3-36] for office buildings.

DIN 4109 [3-34] contains the following requirements:

DIN 4109 Standards

- Protection of rooms against transmission of sound from other residential or working areas (requirements of air and footstep sound insulation) for
  - high-rise buildings with housing and work areas,
  - single-family semi-detached houses and single-family terraced houses,
  - hotel accommodation,
  - medical institutions, sanatoria,
  - school buildings and similar educational buildings

- Acoustic requirements for fittings and plumbing systems

- Protection from external noise (requirements of airborne sound insulation for external building components) caused by noise from road, rail, water and air transport services and by business and industrial areas.

Provision may fall short of the requirements of DIN 4109 only in exceptional cases. Where agreed in advance through contractually binding commitments, an increased level of sound protection e.g. based on DIN 4109, Supplement 2, can be agreed upon.

Commitments of this kind are particularly used if a higher acoustic quality is required for in a building, or if during the design of a building a more acoustically-favourable solution can be achieved for comparitively little additional cost.

Supplement 2 to DIN 4109 contains suggestions on air and footstep sound insulation of building components that are intended to protect against the transmission of noise from other residential or working areas. They relate only to high-rise buildings with residential and working areas, single-family semi-detached houses and single-family terraced houses, hotel accommodation, medical institutions and sanatoria. Supplement 2 to DIN 4109 has not been included as part of the building regulations.

Guideline values from VDI 4100 and VDI 2569

The guideline values in VDI 4100 [3-35] for sound protection levels 2 and 3 give better sound protection than the guideline values of DIN 4109.

In the same way the guideline values for the quantification of sound insulation in multi-storey buildings given in VDI 4100 [3-35] for residential buildings and VDI 2569 [3-36] for office buildings are valid only under private law.

The following tables give an overview of the weighting of levels of quality in the qualitative assessment of the acoustics of buildings (**bold text:** applicable under public law and introduced as part of the building regulation):

Building Component	Sound protection	**DIN 4109**	DIN 4109 Supple-ment 2	VDI 4100 Sound pro-tection level1	VDI 4100 Sound pro-tection level 2	VDI 4100 Sound pro-tection level 3
Sound protection quality		**Protection from unreasonable disturbances, minimum to be observed**	increased	simple, minimum values	normal	increased
Partition walls in residential units	Airborne sound protection: required assessed sound insulation-value R'_W in dB	**53**	≥ 55	53	56	59
Partition ceilings in residential units	Airborne sound protection: required R'_W in dB	**54**	≥ 55	54	57	60
	Footstep sound protection: required $L'_{n,w}$ in dB	**53**	≤ 46	53	46	39
Walls to stairways	Airborne sound protection: required R'_W in dB	**52**	≥ 55	52	56	59
Flights of stairs and landings	Footstep sound protection: required $L'_{n,w}$ in dB	**58**	≤ 46	58	53	46
Entrance doors to residential units which lead onto corridors or entrance halls	Airborne sound protection: required R_W in dB	**27**	≥ 37	27	Calculation based on the values for partition walls in resi-dential units	Calculation based on the values for partition walls in resi-dential units

Table 3.6: Qualitative Building Assessment (Acoustics) for Residential Units in High-rise Buildings

Building Component	Sound protection	Activity, based on the regulations on places of work / type of office	**DIN 4109**	DIN 4109 Supple-ment 2	VDI 2569
Sound protection quality			**Protection from unreasonable disturbances, minimum to be observed**	Increased	Recommendations (minimum requirement depending on the background noise level)
Partition walls and ceilings between unrelated workrooms	Airborne sound protection: required sound insulation value required R'_W in dB	Predominantly mental work/single office with high-level standard	**53/54**	≥ 55	47…52
		Predominantly mental work/single office with normal standard	**53/54**	≥ 55	37…47
		Predominantly mental work/office for several persons, with high-level standard	**53/54**	≥ 55	32…47
		Conference room	**53/54**	≥ 55	52…57
		Occasional high concentration and mechanical work/ single office with low standard	**53/54**	≥ 55	32…42
		Occasional high concentration and mechanical work/ office for several persons with normal standard	**53/54**	≥ 55	32…37
		Predominantly mechanical work/ multiple place office with low standard	**53/54**	≥ 55	27…32
Partition ceiling between unre-lated workrooms	Footstep sound protection: required $L'_{n,w}$ in dB	Predominantly mental work/single office with high-level standard	**53**	≤ 46	46
		Predominantly mental work/single office with normal standard	**53**	≤ 46	53….46
		Predominantly mental work/office for several persons with high-level standard	**53**	≤ 46	53….46
		Conference room	**53**	≤ 46	46
		Occasional high concentration and mechanical work/ single office with low standard	**53**	≤ 46	53
		Occasional high concentration and mechanical work/ mutliple-place offfice with normal standard	**53**	≤ 46	53
		Predominantly mechanical work/ multiple-place office, with low standard	**53**	≤ 46	53

Buildingl Component	Sound protection	Activity, based on the regulations on places of work/type of office	**DIN 4109**	DIN 4109 Supple-ment 2	VDI 2569
Sound protection Quality			**Protection from unreasonable disturbances, minimum to be observed**	Increased	Recommendations (minimum requirement depending on the background noise level)
Walls to stairways	Airborne sound protection: required R'_W in dB		**52**	≥ 55	not defined
Flights of stairs and landings	Step sound protection: required $L'_{n,w}$ in dB		**58**	≤ 46	not defined
Doors leading from entrance halls or stairways to corridors in working areas	Airborne sound protection: required R_W in dB		**27**	≥ 37	not defined

Table 3.7: Qualitative Building Assessment (Acoustics) for unrelated Working Areas in High-rise Buildings

Requirements:

DIN 4109 for federal buildings

For federal building projects, levels below those recommended in DIN 4109 may be provided only in exceptional, justified cases: the levels recommended in VDI 4100, sound protection levels 2 and 3 are to be aimed for.

Verification Procedure:

Proof to be based on DIN 4109, test certificates and quality tests

The proof of parameters related to building components is acceptable where it is based on calculations made in accordance with supplement 1 to DIN 4109. For building components not described there, the verification requires the provision of test certificates for performance tests based on currently appropriate procedures and undertaken by recognised test centres. Quality tests will need to be carried out after completion of the construction on combinations of building components and rooms which are considered as critical in terms of building acoustics.

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ENERGY AND BUILDING SERVICES

CONTENTS

0. GENERAL

Conservation of resources

The following requirements for a sustainable approach to energy, water/ sewage and waste represent the minimum standard to be achieved.

Energy requirement to be reduced in an exemplary manner

The total energy requirement of a building (primarily from fossil energy sources) is to be minimised, by means of building and architectural measures, organisational measures, and measures related to the design of technical plant and installations. This process should take into consideration the principles of economic efficiency and economy.

Comply with § 7 BHO

The assessment of economic feasibility should consider not only the overall economic feasibility of the project but also that of each single design step, in accordance with § 7 BHO.

Develop integrated concepts of energy supply

Integrated concepts for supplying the building with heating, cooling and electricity should be developed under the following aspects:

- Security of supply
- Economic feasibility
- Minimisation of consumption of non-renewable energy
- Reduction of burden on the environment
- Use of regenerative forms of energy
- Comfort

Economical use of water resources

Demands on water resources can be kept to a minimum by the design of water-conserving fittings, the multiple use and recycling of volumes of water and contained materials, and by the appropriate use of rainwater, usually in outdoor areas.

Avoidance of waste; suitable for environmental recycling, environmentally harmless disposal of unavoidable waste

The design of buildings should include consideration of the environmentally harmless disposal of waste arising from the use of the buildings.

1. ENERGY

1.1 Requirements for Energy Conserving Characteristics of Buildings - Necessary Requirements

1.1.1 Structural and Architectural Requirements

The level of energy consumption in a building is decisively influenced by its architectural design.

This affects above all the annual heating requirement, the cooling requirement and the electricity needed for lighting and any mechanical ventilation.

The architects and urban planners therefore have considerable responsibility for the energy conserving characteristics of the design of the building (see also Appendix 2)

1.1.2 Annual Heating Requirement and Annual Energy Requirement for Heating

Standards of the Energy Conservation Act for federal buildings

The proposed Energy Conservation Act [4-2] will intensify the requirements on the energy conserving characteristics of buildings. The draft version of July 2000 has already become part of the basis for the calculations made for federal buildings.

This regulation summarises and updates the current requirements of the Heat Protection Act and the Heating Systems Act.

The Energy Conservation Act follows the European harmonised standards and sets out a new basis for the calculation of heating and energy requirements. In the future, the primary energy requirement must be established that is actually consumed for area and hot water heating. This means that the efficiency of the heating system can be taken into account.

Furthermore, in the future not only will the passive use of solar energy be taken into account; the draft act also favours the active use of regenerable forms of energy. The Energy Conservation Act thus opens up new energy saving potentials whilst maintaining the highest possible freedom of design for new buildings.

Annual heating requirement clearly below currently applicable standards

Requirements:
The provisions of the July 2000 draft of the Energy Conservation Act; later versions will apply from the date of their introduction.

Verification Procedure:
Verification is to be established in accordance with the procedures specified in the Energy Conservation Act.

1.1.3 Heat Requirement - Heating of Drinking Water

The heating of drinking water takes on increasing significance where attempts are made to further reduce the annual heating requirement. The main starting point for reducing the heating requirement here is to cease using hot water (for the energy-saving effects which result from the energy-related optimisation of plant layout, see point 1.2.2).

Use of solar energy

Requirements:
In addition to the technical requirements, the test criteria of the environmental logo "Blue Angel" can be used as a guide for ecological requirements during the selection of solar-thermal systems. The environmental logo should not however be a specified requirement.

Verification Procedure:
A performance and working balance sheet is to be submitted for the heating energy required for the heating of drinking water, sorted in order of the main consumers. The analysis has to use procedures as in DIN V 4701-10.

1.1.4 Electricity Requirement

The economical use of electricity is of special importantance.

Total Electricity Requirement

Economical consumption of electricity should follow the recommendations of the Swiss Association of Engineers and Architects

The planning of the electricity requirement should be based on the recommendations of the Swiss Association of Engineers and Architects (SIA 380/4) [4-3].

Particular attention is to be paid here to the sections on lighting, VAC-systems, heating, hot water preparation and working equipment. If elevators and canteens/kitchens are planned, separate investigations are to be made into reducing their electricity requirements. The proportion of the electricity demand, which is to be considered under the Energy Conservation Act, is to be shown separately from the rest. (However, the values in Table 4.1 include this proportion.)

Requirements:
The following limiting values are to be observed and the following target values are to be aimed for (Recommendations of the Swiss Association of Engineers and Architects SIA 380/4 [4-3] - reference area in SIA 380/4 is the gross floor area; in addition, the relation to the net floor area is also to be indicated):

Office Buildings	Related to NGF (net floor area)		Related to BGF (gross floor area)[1)]	
	Target values [kWh/(m²a)]	Limiting values [kWh/(m²a)]	Target values [kWh/(m²a)]	Limiting values [kWh/(m²a)]
Predominantly single office rooms or multiple offices, with normal level of equipment (< 1 PC for every workplace), large proportion of workplaces near the windows, minor proportion or no ventilation/ air-conditioning systems	15	30	13	27
Predominantly multiple and open-plan offices, with technical equipment (additional workplace equipment such as printers), some workplaces with a small amount of daylight, larger proportion of ventilation/ air-conditioning systems	25	50	22	43
Predominantly multiple and open-plan offices, more extensively equipped (additional workplace equipment such as printers), some workplaces with a small amount of daylight, larger proportion of ventilation/ air-conditioning systems; plus additional large-scale computer equipment	60	90	53	77

Table 4.1: Limiting and Target Values for the Electricity Requirement of Federal Buildings

1) provided that NGF/BGF = 0,87

Verification Procedure:
Verification is based on the installed connected load per m² NGF (net floor area), assuming peak load hours occurring at the same time. The verification is to be based on the approach used in SIA 380/4 [4-3].

A performance and working balance sheet is to be submitted. The recommended values of SIA 380/4 [4-3] are to be applied for peak load hours occurring at the same time, provided that building-specific values are not being estimated.

Energy Required for Lighting

Use of daylight as much as possible

Use of energy-saving lighting

Daytime-and presence-dependent lighting control

A reduced level of energy for lighting can be achieved by:

- Use of daylight as much as possible
- Use of types of lighting with a high efficiency factor
- Use of electronic pre-switches where fluorescent lamps are used
- Use of lighting control systems

Requirements:
As a guideline for the installation, lighting equipment should not exceed the following specific electrical output. The reference area is the utilisation area (see also Appendix 2).

Zone	Rated Illumination Strength	$P_{max.\ spec}$ [W/m²]
Office rooms	300 lx at the workplace 500 lx	10
Conference room, meeting room, conference hall	300 lx	15
Corridors	50 lx	3
Stairways	100 lx	5

Table 4.2: Allowable Specific Values of Output for Lighting in Federal Buildings

Note:
The values for working requirement should be based on values for full load hours occurring at the same time, and based either on SIA 380/4 [4-3] or on own established values.

For outdoor facilities, a purpose-based and economical level of illumination using effective means of lighting is to be designed.

Verification Procedure:
Submission of a performance and working balance sheet, differentiated by zones.

Electric Energy Requirement for Ventilation and Air-conditioning Systems

Design of VAC-systems should include volumetric air currents adapted to the demand, design of low pressure-loss air ducting systems and of ventilators with a high level of efficiency

The electricity requirement of ventilation and air-conditioning (VAC) systems may be lowered by reducing the volumetric air currents to the amount needed, the design of low pressure-loss air ducting systems, the use of highly efficient ventilators and motors; and through a suitable control and regulation system which uses the full extent of the permitted ranges of air temperature and humidity.

Requirements:
Limitation of specific electricity requirement for ventilator drives to the values allowed in SIA 380/4.

Where European Standard CEN/TC 156/WG 2 N 230 [4-4] is applicable, then this standard is to be observed.

Verification Procedure:
System-related performance and working balance sheets are to be submitted for the electrical power units of VAC-systems.

These should consider the volumetric open air currents needed for hygiene, the circulating air currents, pressure loss and degree of efficiency and the hours of operation. The full ranges permitted for air temperature and humidity are to be used here, the aim being to minimise the energy requirement. Operation of the equipment according to "best values" is not allowed. The optimum duration of disconnected time and partial load states reduce the electricity requirement and are to be included in the balance sheets.

Electricity Required for Heating and Hot Water Preparation

Basis of comparison:
The electricity required (for heating) should be a maximum 1 % of the annual heating requirement

Central boiler rooms should be fitted with energy-saving, self-regulating heat circulation pumps. For solar-thermal plant, the preferred type of solar circulation pumps are energy-saving pumps with low-voltage DC motors connected with photovoltaic modules. The total annual auxiliary energy which is to be used for heating devices and hot water preparation devices is not to exceed 1 % of the annual heat requirement for hot water and room heating. The electricity required for heating and hot water preparation is to be measured by separate electricity meters.

Electricity Required for Working Equipment

When procuring new equipment, buy energy-saving devices
Reduction of losses caused by idle running time

Working equipment (pluggable electrical devices such as computers, copying machines etc.) consume up to a quarter of the total energy requirement in office buildings. It is therefore particularly important to procure energy-saving devices and to reduce idle running time losses.

Requirements:
Where electrical equipment is technically similar, equipment should be preferred which consumes as little electricity as possible both in normal and in idle operation. Provided that it is operationally allowable, equipment should have a switch whose function is to disconnect it completely from the mains supply.

In addition to the functional requirements, the test criteria of the environmental logo "Blue Angel" and the GED energy-saving label provide up-to-date guidelines on the reduction of energy consumption. The labels themselves should not however be a specified requirement.

The use of equipment made to a comparable standard is also allowed.

Personal equipment is not to be used

Electricity-consuming personal equipment which is connected to the mains supply may not be used in federal buildings.

Comply with other ecological criteria

Other ecological criteria must also be complied with.

Working equipment	Environmental Logo "Blue Angel"	GED-Energy Conservation seal
● Workstation computer	X	
● Portable computers (laptop, notebook)	X	
● Printer	X	X
● Copying equipment	X	X
● Multifunctional devices		X
● Fax machines	X (in preparation)	X
● Television	X	X
● Video system		X
● Hand dryer	X	
● Refrigerators and freezers	X	

Table 4.3: Equipment bearing the "Blue Angel" Environmental Logo [4-5] or the GED-Energy Conservation Seal [4-6]

Provision of performance and working balance sheet

Verification Procedure:
A list of proposed electrical equipment is to be submitted. In connection with this, a performance and working balance sheet is to be established which should also show the power consumed during idle operation. A simple addition of data taken from the type-labels is not allowed.

1.1.5 Annual Cooling Requirement

See also Appendix 2

Various possibilities exist for minimising demand for cooling, in particular by providing adequate heat insulation during summer periods.

Offices, as a rule, to be without cooling facilities, adequate building insulation to be provided against summertime heat

Requirements:
Office buildings are, as a rule, to be designed so that mechanical cooling will not be necessary. In addition, a structural insulation against summer-time heat is to be provided. Simple solutions are to be aimed for.

Where a cooling system still proves necessary, inspite of having complied with the recommendations on insulation against summertime heat, then a cooling load calculation is to be submitted.

It is recommended that the optimisation of the building design in connection with insulation against summertime heat, and in consideration of the heating requirement, is made using recognised dynamic thermal building simulation techniques.

Verification Procedure:
A performance and working balance sheet is to be submitted, listed separately for each main consumer. The power requirement is to be substantiated by submitting a cooling load calculation made in accordance with VDI 2078 [4-7]. In addition, proof of an adequate summertime heat insulation is to be established in accordance with the Energy Conservation Act and the accompanying regulations (DIN 4108-2 and DIN V 4108-9).

1.1.6 Building Simulation

Thermal building simulation for decision-making

For large buildings and building complexes, the design should involve the use of detailed dynamic thermal building simulations using recognised programs and on the basis of hourly data. These serve both as a design and planning tool and as evidence of the energy conserving quality of the building as well as the need for technical measures.

1.2 Energy Conserving Requirements of the Building Installations

Technical concepts optimised for energy conservation

Energy conserving, optimised technical concepts should be developed that take into account the need for economic efficiency and guarantee of supply.

The interaction between utilities plants and services with their operators and users must be taken into consideration from the very beginning of the project.

Building automation in accordance with DIN 276 [4-8] and DIN 18386 [4-9] plays a key role in the conservation of resources, the protection of the environment and the economic efficiency of the building's operation.

An integrated concept for the building automation is an essential part of the function and usability of the building's utilities and services such as heating, ventilation, air-conditioning and sanitary facilities. At the same time the concept provides a tool for the technical building management and also monitors the building infrastructure systems such as power supply, communications and security.

In order to limit the necessary investment, the possibilities of stage-based solutions should be examined.

Comparison of various systems and derivation of a preferred solution from competing technical solutions

Where different, competing building utilities systems are available, for which the relative advantages and disadvantages are not directly apparent without detailed investigation, then comparisons of the systems are to be carried out.

The technical solutions are to include:

- Comparison of alternatives from the business management point of view (investment, annual costs based on annuity procedures)
- Energy and emission balance
- Recommendation of a preferred solution.

Comply with AMEV

The recommendations of the AMEV are of particular relevance to public buildings. They apply to the design of building services and utilities (heating systems, ventilation and air-conditioning, sanitary facilities, electrical plant and lighting).

1.2.1 Heating

Implementation of the Regulation on Heating Systems

The basis for the design and operation of heating systems is the Energy Conservation Act, in particular with regard to limiting the standby operation losses, heat insulation, the use of heating pumps and the provision of control and regulating equipment.

Avoidance of unnecessary energy losses

The heating equipment must be designed to avoid unneccessary loss of energy. Where economically appropriate and permissible, it must also be adapted to suit the spatial conditions and the user's expectations of comfort. Minimal energy losses can be achieved by an optimum network design, an adequate heat insulation of the pipelines, by laying the pipelines within the heat transferring outer surfaces of the building and by an optimal distribution into heating circuits. Incident sunlight is to be taken into consideration by means of a facade-dependent zoning of the heating systems in the regulating process.

Designing heating systems appropriate to the user requirements and building structure

Parts of the building which have different requirements are to be provided with separate control circuits. Pipeline networks must be calculated and optimised; and a hydraulic balance has to be made before commissioning them.

Pumps in the heating systems are to be dimensioned exactly; care must be taken to ensure the lowest possible consumption of power.

The heating systems should be provided with the number of monitoring instruments needed to ensure their safe and economical operation.

Creation of technical conditions for a long-term optimised operation

Where extended regulating concepts are to be implemented, the local regulating system should take into account a high level of flexibility in the layout and division of rooms. The lay-out of the regulating circuits and installations must be designed so that - where necessary - with any repositioning of walls, they may be combined into room regulating circuits.

Besides providing for central control and regulation, the possibility and economic feasibility are to be assessed of providing means for setting target values for each room and for setting up a time-based programme of control. Details of users are to be collected to an extent sufficient to allow a rough analysis to be made of the total consumption of each utility.

Particular attention is to be paid to the economically efficient control of plant and equipment and the minimisation of negative user effects.

1.2.2 Heating of Drinking Water

Design of energy-efficient hot water supply systems

A decision not to use hot water systems (see also section 1.1.3) can substantially reduce the expenditure for plant and equipment needed for the heating of drinking water.

The following requirements apply to the remaining areas to be supplied with hot water (kitchens, canteens etc.):

- Compliance with the hygienic requirements for drinking water
- Rational consumption of energy and drinking water
- Optimisation of system and operational costs as part of an overall economic solution

Include solar-assisted hot water supply systems

Where a simple assessment is not possible, centralised and decentralised hot water supply systems are to be investigated with regard to each separate land holding. The investigation should include consideration of technical solutions for low-loss hot water systems as well as for solar-assisted hot water systems.

For protection against the formation and spread of legionaire's bacteria in systems for heating drinking water, attention is drawn to the standards of DVGW-Working Papers W 551, W 552 and W 553 [4-11 to 4-13].

1.2.3 Ventilation and Air-conditioning Engineeering

Ventilation

Development of an overall ventilation concept

A ventilation concept should be developed for every building. The concept should comply with the requirements for indoor air hygiene and humidity (see also Appendix 2).

Free ventilation system is to be preferred

The free ventilation is to be preferred, provided that the regulations do not call for a mechanical ventilation system.

Comparison of various systems of mechanical ventilation

A recognised computer-based simulation of ventilation can show that these requirements may be satisfied by means of a free ventilation system.

Selection of an economical, energy-optimised system

In offices, use is also preferred of ventilation systems with controlled inflow of open air, and of air supply- and exhaust systems with or without heat recovery facilities. The choice of the system should be based in particular on the following aspects:

- Noise emissions in external rooms
- Safety requirements
- Enhanced immissions in outdoor areas
- Assurance of minimum air exchange and/or of required air demand
- Energy conserving efficiency based on an energy balance, including use of auxiliary energy under real working conditions

The necessary investment as well as the economic feasibility of the installation of indoor air systems are to be described and included in the decision-making process.

The requirements of RAL-quality seal GZ 652 "Ventilation and Air-conditioning Systems" or equivalent standards should be observed. The seal itself shall not be set as a required condition.

Air-conditioning

The need for an air-conditioning system is to be proven

The need for partial and full air-conditioning systems is to be demonstrated (cooling load calculations, evidence of the need for humidification and/or de-humidification).

Where alternative systems are available, their economic feasibility must be compared and presented

Where alternative systems are available an assessment of their economic feasibility is to be made.

Cooling

The basic principle is that the use of cooling systems must as far as possible be avoided. External heat sources should be minimised (e.g. by providing external shading). The need for ventilation is then only likely where there are still high internal heat sources or where cooling is essential. In general, mechanical (forced) ventilation may be installed in offices in which free ventilation is not appropriate due either to high noise levels or to reasons of safety. The need for a cooling system must be demonstrated.

Layout of cooling plant to be based on the proven demand

The cooling plant must be carefully designed so as to avoid unnecessary energy losses and so that it fits closely into the space constraints. Minimal energy losses can be achieved through an optimal division into cooling circuits. Incident sunlight and the zoning of the cooling plant are to be considered in relation to the facades when developing the control processes.

Avoidance of unnecessary additional expenditures

Parts of buildings with different requirements are to be equipped with separate control circuits. Pipe networks must be calculated and optimised; a hydraulic balance has to be made when commissioning the equipment. Pumps in the cooling plant are to be dimensioned exactly and the regulation of rpm (revolutions per minute) is to be applied consistently.

Energy for cooling preferably derived from waste heat or regenerative forms of energy

Driving power for the active cooling systems should primarily be provided by waste heat and regenerative forms of energy.

The use of fossil fuels or sources of energy based on fossil energy is to be avoided.

Where competing cooling systems are available, the decision should be based on a consideration of economic efficiency.

Lighting

Use of energy-saving lighting

The possibilities of extensive use of daylight must be fully applied, taking into consideration the principles of ergonomics, energy conservation and economic efficiency. Only energy-saving lamps may be considered in artificial lighting, but not incandescent lamps and halogen incandescent lamps. Any exceptions to this rule must be justified.

Daytime-dependent and/or presence-dependent lighting control

The question of the economical use of daylight-dependent and/or presence-dependent lighting control (if necessary, simple systems) is to be resolved through a consideration of economic efficiency.

Energy Management

Efficient energy management

Federal buildings shall be arranged and organised in accordance with an efficient energy management, which is an integral part of the goal of comprehensive facility management.

Principles of energy management - an efficient building automation

One principle of energy management is illustrated by the building automation. This should provide for the functional integration of all automated components such as boilers, cooling plants, ventilators, pumps, single-room control systems, lighting control systems, sun protection etc. These components should also be included in a wider overall concept for the building operation. Only then can they enable "energy-conscious" and "cost-conscious" operation of the building by means of their control, monitoring and fault reporting functions, with their time-dependent, event-dependent as well as peak-load limiting action programmes.

It must also be ensured that the other service facilities of technical building installations (such as heating and indoor air systems, sanitary facilities, electronic devices, information systems, hazard, security and supply systems) work together with each other and with the building technology. This can be achieved by, for example:

- Control and regulation of the energy flows with the aim of maintaining the optimum parameters in the building interior; the control and regulation is dependent on various external factors such as open air temperature, incident sunlight, absence of the users
- Co-ordinate the load-dependent adjustment of energy supply systems to the operation of transparent, heat-insulated facades and, as necessary, with parts of buildings parts equipped with photovoltaics
- Control of light dimmers and venetian blinds based on indoor and open air conditions and on the co-ordination of shading and air-conditioning facilities
- Compensating peak loads of electricity demand

Appropriate technical provisions are to be implemented to ensure the communication between different technical components and functions on the one hand, and products from different manufacturing companies on the other hand.

In energy management, the guidelines on designing for the economical consumption of energy are to be observed, the level of consumption further optimised and the optimised low level of consumption permanently maintained.

Monitoring facilities must be established to allow the recording of the most important key energy and economic data. This will lead to an understanding of the actual consumption of energy. Meaningful data must thereby be made available at regular intervals.

The design requirements (planned values) are to be compared with the actual levels resulting from use and operation of the equipment (observed values). Any differences which are observed between these are to be investigated and corrected.

1.3 Requirements for Energy Supply

Integrated concepts are to be developed for the supply of federal land-holdings with heating, electricity and cooling, taking into consideration the following aspects:

- Economic efficiency
- Security of supply
- Minimisation of total energy consumption
- Reduction of environmental impact
- Use of regenerative forms of energy

Develop energy supply concepts

The development of energy supply concepts is necessary where alternative, competing options for energy supply are available, and where the advantages and disadvantages of these options are not apparent without further investigation.

Requirements:

Selection of preferred solution

In addition to the economic efficiency, considerable importance is placed on the function of the proposed means of energy supply as a model solution, as well as its ecological sensitivity.

Utilise coupled power and heating plants preferably

The primary source of electricity and heating should preferably be provided by efficient coupled power and heating plants.

Where a decision has been made to use renewable forms of energy within the budget granted to the building project under § 24 BHO, the following has to be observed:

High proportion of regenerative forms of energy

For federal buildings with a construction cost of more than 5 million E, at least 1% of the construction cost should be invested in renewable forms of energy. Minor deviations from this requirement will be permitted, depending on the type of building and the importance of the project.

The aim here is for 15 % of the total energy needs of the building/land-holding to be covered by renewable sources of energy.

For this guideline, renewable sources are defined as supplies of energy to the building or landholding which are generated by one or more of the following, and which can be utilised by appropriate technical plant and equipment:

- Sun
- Wind
- Ground heat/cold
- Hydroelectric power
- Geothermal energy
- Biomass

With the development of an energy supply concept the following has to be submitted:

- Forecasts of consumption for heating, electricity, cooling
- Alternative means of energy supply (technical concepts)
- Comparison of alternatives in business terms (investment, annual costs)
- Energy and emission balance
- Recommendation of a preferred solution

2. WATER / SEWAGE

2.1 Requirements for the Economical Consumption of Energy

Water-conserving fittings and sanitary installations

Only water-conserving sanitary fittings are to be used. The flow volumes for hand-basins for example are to be reduced to a maximum of 6 l/min, or ensured with the use of flow restrictors.

For toilet areas, this measure can most effectively be achieved by the use of water-conserving installations or installations which do not use flushing water (e.g. water-free urinals).

2.2 Requirements for Public Health Engineering (Water Supply and Drainage)

Installations to be combined

The installations are to be combined and located in the area of greatest demand. Supply and drainage networks should be laid in common service shafts and pipes.

To permit the direct measurement of consumption and preparation of invoices, cold and hot water meters switched to the GLT are to be provided for each separate unit using the systems.

Selection of materials

Selection of material used for the pipes should take both the chemistry and quality of the water/effluent and the expected operating temperatures into consideration.

Transmission of sound to the building structure is to be prevented through the selection of appropriate materials, fixings and the routing of the pipes. The insulation of the water supply and drainage pipes (heat losses, temperature falling below the thawing point) is to be checked with reference to the local fire protection requirements.

No additional water treatment

Additional water treatment measures (e.g. water softening) are to be limited to cases which, for technical reasons, cannot be avoided.

Operational water systems and operational water points must be appropriately labelled.

Lines to be laid above the backpressure level

Sewage intakes and lines must not be laid below the backpressure level, to avoid the use of pump stations.

3. WASTE

3.1 Avoidance of Waste during Building Design and Construction

Avoidance of waste, unavoidable waste to be recycled, non-recyclable waste to be disposed of in a manner suited to the public interest

Existing building materials to be preserved, long-lasting and recyclable building materials to be selected

The design and construction of buildings to meet a given need for space must also satisfy a number of other requirements. These include the requirements of the Law on Recycling Economy and Waste (which is designed to conserve natural resources), the avoidance of waste, the greatest possible high-value and orderly reuse of unavoidable waste, and the disposal of non-reusable waste in a manner suited to the public interest. These measures should allow for consideration of the continued use of existing building structures and the selection of building materials based on criteria of durability and potential for reuse. Further, the disposal of waste is to be designed, tendered, monitored and balanced (see the Regulation on Verification Procedures - NachwV, Ordinance for Waste Management Concept and Waste Balance Sheet - AbfKoBiV). The BMVBW working note on recycling "Avoidance, Recycling and Disposal of Waste Products during the Design and Construction of Buildings " apply here.

With the exception of the regulation on minimum quantities (1 m³) according to VOB, Part C, DIN 18299, methods for the disposal of waste channels are to be designed, tendered, monitored and balanced (in accordance with the Ordinance for Waste Management Concept and Waste Balance Sheet - AbfKoBiV see working notes "Recycling").

The former generally-used clause in tenders which said that "Demolition material (waste) becomes the property of the contractor" is no longer to be used. The designer and the person preparing the tender are thus responsible for the disposal of building waste. The methods of waste disposal proposed by the contracting company should be confirmed by the company in writing, for example in the tender documents or in the contract.

Waste to be dealt with in a manner compatible with its later reuse

Creation of waste should be avoided as much as possible during building construction. Unavoidable waste must be stored so that it is possible to recycle it. Waste, which must be disposed, is to be kept to a minimum and separated from recyclable waste.

Use-related waste to be kept to a minimum

Establish conditions to permit the separation of waste and the collection of recyclable materials

Buildings must be designed so that waste resulting from their use is kept to a minimum and that during their use it is possible to recycle unavoidable waste in an environment-friendly manner. This includes the establishment of facilities in the building to permit the separation of waste and the collection of valuable materials.

Avoidance of Waste resulting from the Operation of Buildings

Consider waste avoidance when fitting out the building

During the utilisation phase, the procurement of furnishings and technical installations should be made bearing in mind the criteria of environmental sensitivity, the protection of health and of durability, reuse and ease of repair. Unavoidable waste should be separated by type (e.g. reuseable/ non-reusable) and subjected to either an orderly and harmless method of recycling or to a method of disposal most suited to the public interest (see also the Appendix on "Design Principles for Outdoor Facilities").

The volume of waste created is to be documented and evaluated periodically, at least once a year.

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DESIGN PRINCIPLES FOR OUTDOOR FACILITIES

CONTENTS

0. GENERAL

The Appendix "Design Principles for Outdoor Facilities" presents important aspects which can be of significance in the design, construction, operation and eventual later demolition of building measures on outdoor facilities. However the Appendix does not claim to cover these aspects comprehensively.

In individual cases, reference should also be made to the requirements and notes in the relevant standards, federal working notes, regulations, decrees etc. for the specific building measures.

1. DESIGN

1.1 General Design Principles for Outdoor Facilities

Consider the reuse, extension, conversion or rehabilitation of existing facilities

Before deciding on the construction of new outdoor facilities, a review should be made as to whether the need can be met by the reuse, extension, conversion or rehabilitation of existing facilities or plant.

Comply with § 7 BHO

The assessment of economic feasibility should consider not only the overall economic feasibility of the project but also that of each single design step, in accordance with § 7 BHO.

Comply with the working notes on “Contaminated Sites”, “Sewage” and “Recycling”

The local situation is to be reviewed and assessed in terms of damaging changes to the environment, suspected contaminated sites, polluted building structures, and contamination of soil and water. Here the working notes on "Contaminated Sites", "Sewage" and "Recycling" amongst others are to be observed.

Minimise soil excavation

Soil management is to be carried out. Minimisation of soil excavation can be achieved through an optimal design of the outdoor facilities. Unavoidable excavated soil is to be left on the property or recycled elsewhere.

Plan for long-term use

Document building methods and materials

Give preference to designs which are easy to demolish and which use low levels of harmful substances

The outdoor facilities should be designed for long-term and where possible, for multi-functional use. Environmental data and building materials and methods suitable and relevant for later reuse are to be particularly highlighted in the documentation. Preference is to be given to designs which are easy to demolish and which use construction techniques involving low levels of harmful substances.

Accessibility is to be ensured to parts of the facilities which require maintenance or are likely to require repair.

Use quality-controlled recyclable building materials

As a matter of principle, quality-controlled recyclable building materials are to be used unless engineering or other reasons are against this (e.g. long transport distances).

Traffic Facilities

Comply with RV 96

When designing traffic facilities (e.g. access roads, parking and standing areas, residential and emergency access ways etc.), reference is to be made to the regulation "Design, Construction and Maintenance of Transport Facilities" (RV 96).

Immissions to be kept away from residential and working areas

Access roads should preferably be connected by the shortest route to the local and public network. Provision should be made for connecting the building to the local public transport system and to an internal pedestrian and cycle network.

Allow for multiple use of traffic areas and surfaces

Multiple use of traffic areas is to be aimed for, e.g. by shifting the focus of use of traffic areas towards pedestrians (mixed use of the area). The arrangement of parking areas should be such as to minimise the number of accesses needed.

Minimise emissions

Measures for traffic control and traffic calming are to be included in the design in order to avoid traffic-generated emissions.

Improve microclimate

In order to improve the visual effect and the local microclimate, consideration should be given as to how far economical measures can be taken to make the surfaces of traffic facilities more attractive by planting and to integrate them as inconspicuously as possible into the surroundings.

Energy consumption to be minimised

A requirement analysis should be made for lighting and traffic control installations, in order to reduce their number and operating times to the minimum necessary. Regenerative forms of energy and energy-saving technologies should be used provided that these are economically feasible.

1.2.1 Paving of Traffic Facilities

The selection of pavement construction should be based on future traffic loading. The dimensions of the individual layers in the pavement should be based on the type of use the pavement will be subject to (e.g. Guidelines for the standardisation of road pavements RStO). It should be determined if surface infiltration techniques are permitted or, with respect to the expected traffic demand, are possible.

Type of construction	Areas of Application
Wearing courses without binders	
Wooden and bark-covered surfaces	- rarely used footpaths
Gravel lawn	- occasionally used parking areas - standing areas - rarely used hard shoulders and median strips
Unbound pavements	- footpaths and cycleways - lightly loaded (occasionally used) accessways - standing areas and parking areas
Permeable set paving	
Grass pavers	- parking areas - garage driveways and fire service accesses
Porous stone paving	- residential streets, squares, yards, schoolyards - parking areas, entrances, footpaths and cycleways
Open joint paving	- squares, paths, yards - parking areas
Partially permeable paving and flagstones	
Medium / large paving stones	- residential streets, squares, yards, paths - parking areas
Concrete / clinker paving stones	- residential streets, squares, yards, school yards, parking areas, entrances
Flagstones	- rarely-used residential streets, squares, yards, school yards, parking areas and entries as well as footpaths and cycleways
Wearing courses with binders	
Bituminous and concrete pavements	- very busy streets and parking areas - yards with business and industrial use
Concrete pavements	- special parking areas and - uses

Table 5.1: Traffic Facilities - Types of Construction and Areas of Application

Table 5.2: Qualitative Assessment of Construction Styles for Traffic Areas
1) for concrete paving stones: average

	Wooden and bark covered surfaces	**Gravel lawn**	**Unbound pavements**	**Grass pavers**	**Porous stone paving**	**Open joint paving**	**Medium/ large paving stone**	**Concrete / clinker- paving stone**	**Flagstones**	**Bituminous pavements**	**Concrete pavements**
Noise emissions (surface)	low	low	low	average	high	high	average	average	average	average	average
Natural habitat (plants, animals)	high	average	low	high	low	low	low	low	low	--	--
Water permeability	high	high	average	high	average	average	low	low	low	--	--
Maintenance cost	high	high	average	average	average	average	low	low	low	low	low
Investment costs	low	low	low	average	average	high 1)	high	average	average	average	high
Costs for value-preserving maintenance	hoch	high	average	average	average	average	average	average	average	low	low
Demolition costs	low	low	low	average	average	average	average	average	average	high	high

1.3 Outdoor Facilities

Use plants suitable for the location

Rainwater to be used for irrigation

Locally appropriate and primarily indigenous plant species should be used for planting. When selecting the types of plants to be used, consideration should be given to their watering needs, in order to avoid as much as possible the need for additional irrigation of the areas. If artificial irrigation is necessary, preferentially rainwater should be used.

Promote the natural succession

Interlink biotopes

Space should be left to allow natural succession in the vegetation structure. New planting and new areas with a variety of biotopes are to be integrated into existing biotopes / partial biotopes. They are to be adapted to the existing population and existing ecological conditions (e.g. vegetation, topography). Biotope networking can be promoted by the use of stepping-stone biotopes (e.g. ponds, meadows, coppices) and composite biotopes (e.g. weed-covered verges, hedges, ditches).

Consider maintenance costs

The selection of plant types should also take into consideration the maintenance requirements. In order to restrict the growth of undesirable wild plants, planting of ground cover should also be carried out (e.g. on cut tree sections).

Material cycles to be closed

Bearing in mind the requirements of the areas and of personnel, organic waste should be left on the sites. As a rule the leaves and the cuttings from mowing should not be completely removed.

For sports facilities, attention is drawn to the "Standard design of outdoor sports facilities for the federal armed forces" .

For the planting of trees and bushes the following characteristics of the plants are recommended:

Single trees	STU max. 20/25 cm
Single bushes	3 - 4 x v.H max. 150 cm
Trees	STU 12/14 cm
Bushes	2 x v.H 80-100 cm

1.4 Water

1.4.1 Rainwater

Rainwater which does not require treatment should where possible be used as operational water (e.g. for irrigation) and/or left to seep away onsite.

Observe the working notes on “Sewage” (chapter 5)

Drainage of rainwater is to be provided close to the surface and in an appropriate manner (e.g. in gutters). The rainwater drainage pipes should preferably lead into the landscaping (e.g. via ponds). Seepage should generally be through the active layer of topsoil. Soakaways may therefore only be built in exceptional cases. When designing for seepage, the use of cost-effective alternative methods should be investigated, e.g. provision of areas or hollows for seepage. The working notes on "Sewage" (chapter 5 "Use of Rainwater") are to be referred to.

For free-draining areas (e.g. roofs or traffic areas), materials should be selected based on local constraints and which limit the output and accumulation of pollutants in the soil.

1.4.2 Water Supply and Drainage

Observe the working notes on “Sewage”

When designing drainage facilities the requirements of the working notes on “Sewage" are to be observed.

As far as possible sewage should be collected in separate channels (separating systems). An appropriate treatment is to be ensured.

The length of pipelines for supply and disposal systems should be minimised and the layout should be optimised.

Ecologically desirable use of rainwater

Rainwater should be used as far as possible for the irrigation of green areas (e.g. gardens, plantations) and for cleaning purposes in outdoor areas (e.g. as a substitute for drinking water in washing facilities).

Washing facilities should be equipped with water treatment and circulation systems.

Provide ponds for the storage of water for use in fire-fighting

The supply of water for fire-fighting emergencies must be ensured, where possible by providing "fire-fighting ponds" for water storage. Suitable facilities should be provided for retaining polluted fire-fighting water.

1.5 Waste Disposal

Compost bio-degradable waste on the property

Biodegradable wastes (especially waste from plants etc.) should be composted on the property, provided that this can be done in an orderly and harmless manner and that the structural and operational conditions can be satisfied. This calls for regular maintenance and care, suitably trained personnel and a sufficiently large storage area for the resulting compost.

Facilitate initial separation of the accumulating waste

The building facilities should allow for an easily manageable pre-separation of accumulating waste. Adequate, large areas should be provided outside the building for standing of suitable waste containers. At least the following waste materials should be collected separately: waste paper, glass (separated by colour), bio-degradable waste, light wrapping material ("Green Point"), residual waste, waste which requires special supervision, and significant volumes of other use-specific waste. The design is to provide for extension areas for additional containers which may needed in the future.

2. CONSTRUCTION

Avoid root zones, ensure the topsoil's vitality and ability to function properly

Zones occupied by tree roots are not to be used for traffic areas, storage areas or service utilities pipes. Compaction of soil should be avoided where construction work takes place near infiltration plants, filter ditches and plant beds. Suitably large areas should be provided for excavated topsoil which is to be reused on the property. The vitality and efficiency of the topsoil is to be ensured through seeding and maintenance of the topsoil piles.

Different types of waste to be collected and disposed of separately

Optimise construction site traffic

Uncontaminated mineral waste, contaminated mineral waste, construction waste (non-mineral) and waste which requires special supervision, are to be collected and disposed of separately. Uncontaminated old building materials should be separated by fractions. Construction site traffic should be kept to a minimum by optimising the delivery and storage of materials.

Energy-saving, low-noise and low-polluting types of machinery and procedures are to be preferred.

Step ditches to be examined

The location of service utilities pipelines in a common trench (stepped ditch) should be aimed for.

3. OPERATION AND VALUE-PRESERVING BUILDING MAINTENANCE

Service and maintain outdoor facilities regularly

The service and maintenance of outdoor facilities (green areas, drainage systems etc.) should be carried out on a regular basis. In the maintenance of green areas, the use of an integrated approach to plant protection, including e.g. non-use of pesticides and insecticides, and environment-friendly techniques for removing weeds have to be considered.

Protect retreats and reserves for the fauna

Measures for the maintenance of green spaces may be temporally postponed in order to create retreats and food reserves for the fauna. Use of mineral fertilizers should be avoided as much as possible. Peat is therefore not suitable here.

Dry cleaning processes and machines with internal water-recycling systems should be used for sweeping. Initial cleaning of paved surfaces using brushing machines should not be made; rather hand cleaning should be used here.

4. DEMOLITION

Observe the working note on “Recycling”, minimise material flows (cascade model)

Preservation of existing building components and green spaces (including vegetation and stocks of trees) is to be aimed for. Reusable building parts and difficult material should be removed before commencement of demolition. As much as possible of the material resulting from the demolition should be recycled.

ASSESSMENT OF THE SUSTAINABILITY OF BUILDINGS AND LANDHOLDINGS

CONTENTS

Note:
This Appendix is only to be used with the general section of the Guideline for Sustainable Building.

1. GENERAL

Appendix 6 is used for assessing the sustainability of projects. The ecological, economic and socio-cultural aspects can be assessed independently of each other, using the stipulated criteria. The ecological and economic assessments cover the full life-cycle of the project up to and including its demolition, although the ecological part is presently not carried out on a monetary basis. Social and cultural aspects complete the assessment of sustainability. The weighting of different criteria is a difficult task that requires considerable expertise.

2. OBJECTIVES

The assessment of sustainability comprises separate assessments for the ecological, economic and socio-cultural aspects. These assessments cover the full life-cycle of the building or landholding, and so as a rule cover a period of 100 years.
The results of the three separate assessments (ecological, economic and socio-cultural) have to be integrated into the overall assessment of sustainability.

3. ECOLOGICAL ASSESSMENT

A difference has to be made between qualitative (descriptive) and quantitative (calculative) methods for the ecological assessment of buildings and landholdings.

Qualitative assessments are easier to carry out than quantitative assessments. However, due to different systems limitations or to different reference values, the results of such assessments often cannot be compared with each other, or are not meaningful enough.

Quantitative assessments on the other hand are clearer, but are also associated with a considerably higher workload, in particular due to the large amount of data required. This makes the use of computer-based tools both necessary and sensible.

Qualitative and quantitative methods of the ecological evaluation of buildings and properties complement each other. In both methods, the different system limitations and assumptions must be clearly described.

In the early design phases (competitions etc.) the necessary input data for a quantified assessment are not yet fully available. This means that a qualitative procedure should be used for the initial assessment (preliminary assessment). As the design process becomes more specific, this should be turned into a quantitative assessment (in-depth assessment), which eventually leads to an overall assessment.

Until the required computer-based tools have been developed, only the preliminary assessment should be carried out. The basis and the procedure for the in-depth ecological assessment and the tools necessary to carry this out will be explained when the computer-based version of the guideline is introduced (this is expected some time in the year 2001).

Preliminary Ecological Assessment

The environmental effects resulting from a construction process can be described in terms of energy and material flows. Modelling these processes requires considerable effort, so that most of the available planning aids (quality control seals, labels, recommendations, positive and negative lists, declaration rasters etc.) are limited to qualitative aspects. However, the results of qualitative assessments are difficult to compare with each other. There is no simple method of validation and so the existing qualitative procedures are only suited for making a first rough estimate of the anticipated environmental effects.

The criteria shown in Table 6.1 are to be considered in the preliminary assessment. The assessment of each separate criteria within the complex of criteria should be done using alternative methods, whilst considering the specific features of the proposed development. Equal weighting is to be given to the different complex of criteria. Each complex of criteria should result in a rating of "adequate", if the draft is to be included in the subsequent selection processes.
Principles for applying Table 6.1:

Guideline value: In the column guideline value, the values or ratios are to be stated which represent the minimum values to be achieved. The guideline values are to be taken from the current standards and codes of practice as well as from the appendices of this Guideline on sustainable building. In some cases it may not be possible to assign a guideline value to every assessment criteria, in which case qualitative requirements must be established.

Design value: The design value is the value which will be achieved by the specific design. This value can be the same as the guideline value, but it should in principle lead to an ecologically better value (in comparison with the guideline value). Design values, which do not meet the guideline values, will lead to the rejection of the design in question. Deviations may be allowed in well-founded and exceptional cases.

Assessments: In the assessments column, the individual criteria are assessed, either qualitatively or quantitatively. The overall assessment of the individual criteria within a group of criteria will be qualitatively assessed in the complex of criteria which is highlighted in grey (complex of criteria with series numbers 1., 2., 3., 4., 5.1, 5.2 and 6.).

Assessment marks: <u>qualitative and for the set of criteria</u>

+	adequate
+ +	good
+ + +	very good
-	poor
- -	inadequate
●	no information

<u>quantitative</u>

yes	target value reached
no	target value not reached

Assessment Criteria		Guideline Value	Design Value	Assessments: Single criteria – qualitative	Assessments: Single criteria – quantitative	Assessments: complex of criteria
1.	**Realisation of building requirement (analysis of building requirement)**					
1.1	Building requirement	Appendix 2				
1.2	Continuing use of existing buildings	Appendix 2				
2.	**Protective use of building land and natural resources**					
2.1	Use / conversion of derelict industrial land/ military facilities / gaps in built areas	Appendix 2				
2.2	Surface sealing	Appendix 5				
2.3	Area required for transport installations	Appendix 2+5				
2.4	Use of excavated soil within the landholding (mass balance)	Appendix 2				
2.5	Integration into the urban environment or into the landscape	Appendix 2+5				
2.6	Use / protection of groundwater	Appendix 5				
2.7	Use of rainwater within the landholding	Appendix 5				
2.8	Preservation of areas of unspoiled nature and of ecological structures, improvement of the biodiversity of undeveloped ground (compensation)	Appendix 5				
2.9	Remediation of contaminated soil	Appendix 5				
2.10	Constraints for protection against emissions					
	- greenhouse gasses					
	- air pollutants					
	- noise					
3.	**High level of durability and multipurpose-functionality of the building, problem-free demolition**					
3.1	Durability of the building	Appendix 2+6				
3.2	Usability of the building	Appendix 2				

Assessment Criteria		Guideline Value	Design Value	Assessments Single criteria qualitative	quantitative	complex of criteria
3.3	Demolition possibilities of the building	Appendix 2				
3.4	Reuse of building components/materials	Appendix 2				
	- load-bearing structures					
	- exterior walls					
	- ceilings					
	- interior walls					
	- roof construction					
	- building services					
3.5	Recycling of building components / materials	Appendix 2				
3.6	Modular construction/ use of prefabricated building components	Appendix 2				
4.	**Use of health- and environment-friendly construction and fitting out materials**					
4.1	Use of low-emission products	Appendix 3				
4.2	Special requirements	Appendix 3				
5.	**Costs during use of the building**					
5.1	**Rational use of energy**					
5.1.1	Energy-friendly construction method	Appendix 2+4				
	- compact construction method					
	- involve the building substance as a reservoir of heat/cold					
	- proportion of rooms located in the interior					
	- location of rooms with RLT to noisy streets					
	- pipe network for utilities services to lavatories and sanitary facilities, kitchens etc.					
5.1.2	Low energy housing standard / achievement of a high level of structural heat insulation	Appendix 4				
5.1.3	Ventilation of residential areas / natural ventilation of the buildings	Appendix 2+4				

Assessment Criteria		Guideline Value	Design Value	Assessments		
				Single criteria		complex of criteria
				qualitative	quantitative	
5.1.4	Passive use of solar energy	Appendix 2+4				
5.1.5	Use of daylight	Appendix 2+3				
5.1.6	Natural insulation against summertime heat / avoidance of mechanical cooling	Appendix 2+4				
5.1.7	Conditions for the active use of environment-friendly sources of energy	Appendix 2+4				
5.1.8	Integrated energy supply concept	Appendix 4				
5.1.9	Connection to the local public transport system	Appendix 2				
5.2	**Minimisation of other costs during the utilisation phase**					
5.2.1	Cleaning costs	Appendix 2+6				
5.2.2	Water consumption	Appendix 4+5				
5.2.3	Maintenance / inspection	Appendix 6				
5.2.4	Sewage and waste	Appendix 2+4 + 5				
6.	**Building-specific requirements (miscellaneous)**					

Table 6.1: Qualitative Assessment Criteria

If the outcome of the preliminary ecological assessment shows that certain alternatives are to be excluded, then it is not necessary to make a further, more extensive investigation of these alternatives.

3.2 Ecological In-Depth Assessment

The complex task of making an ecological in-depth assessment requires the use of computer-based tools. The basis and the procedures for the in-depth ecological assessment will be explained when the computer-based tools for the guideline are introduced (this is expected some time in the year 2001).

A monetary assessment of all the effects on people and the environment assessed in the impact categories would make it possible to compile all the categories together into a single measure of assessment, which would in turn make it possible to use a simple aggregation. In a monetary assessment, the weighting of the various categories would be based on their share of the costs caused by damage to the environment. It is not possible at the present time to develop reliable information on the effects recorded in the impact categories, because of difficulties with the methodology. Hence a monetary evaluation of the environmental impact as part of the 'balance sheet' assessment cannot be made.

ECONOMICAL ASSESSMENT

4.

4.1

Investment and Post-Construction Costs

When assessing the economic efficiency of building investments, the initial investment and post-construction costs are to be combined and entered as a single assessment criteria in the overall assessment. In the economic feasibility assessment, not only should the total economic efficiency of the project be assured, but each individual planning stage should be assessed for its economic feasibility in accordance with § 7 BHO.

For this guideline, use is made only of the capital value method. In this method, it is possible to compare payments made at different times. Otherwise, the contractual requirements (VV) of § 7 BHO apply.

The rate of interest for the calculation is set each year by the Federal Ministry of Finance. The price inflation rates are based on the developments of the preceding years, e.g. factors on changes in prices are based on information from the Federal Office of Statistics for the period from 1970 to 1996.

One condition for all construction cost calculations and investigations of the economic feasibility of projects is a differentiated cost planning for each of the HOAI design phases. This should be substantiated by cost comparisons based on the final accounts of reference construction projects, calculated on the basis of building units, utilised area, building elements and/or design-oriented tender items.

The above is to be based on the established and updated database of the federal government, the federal states, the architect associations and other advisory bodies. The cost assessment phases - programme costs, cost estimates, cost calculations and deductions - should be based on at least three up-to-date cost comparisons relating to the specific type of building. Comparative and characteristic values are to be assessed in terms of the specific demands on the building and outdoor facilities, the agreed design standards, the construction and the fittings, the special features of the property and the access development; and these values are to be included in the project costing. The sources of the data should be clearly described. Reference building projects for sustainable building as defined by this guideline will be specially highlighted. Additional outlays in the construction costs that result from sustainable building are to be justified, including the operating and utilisation costs.

The appropriate values (guideline and target values) from Appendix 4 for the consumption-related cost groups of water/sewage, heating/cooling and electricity are to be observed, and the costs calculated using local tariffs. The results are to be included in the economic assessment.

In order to arrive at comparable values of key costs, a uniform reference size is defined here. As the building is designed for a particular use, which is represented by the main utilisation area (HFN), the reference unit is set in terms of [€/m² HNF]. Depending on the state of the preliminary design, details should also be given in terms of the reference unit [€/m² BGF].

Detailed design reference values for area and volume, on the basis of comparable objects, are set out in the document "BKI - Building costs from the Building Cost Information Centre” [BKI 1998] and in the "Central collection and assessment of the design and cost data for structural engineering projects” [LAGDAT 1998]. Generally speaking, values estimated from object-related comparable areas are to be preferred due to their higher accuracy.

Summary of Investment and Post-Construction Costs

Assessment Criteria	Unit	Costs	Comments
Building Project Costs **based on DIN 276**	E		
100 Property	E		
200 Preparation and development	E		
300 Building-construction	E		
400 Building-technical installations	E		
500 Outdoor facilities	E		
600 Furnishings and artworks	E		
700 Ancillary building expenses	E		
Investment Subtotal	E		
Building Operation Costs			
Cleaning of the building	E/year		
Water / Sewage	E/year		
Heating	E/year		
Cooling	E/year		
Electricity	E/year		
Service, maintenance, inspection	E/year		
Miscellaneous	E/year		
Building maintenance	E/year		
Building Operation Subtotal	E/year		

5.

SOCIO-CULTURAL ASSESSMENT

The participation of artists ("Kunst am Bau" = Art in Construction) as well as the treatment of cultural and historical discoveries are regulated in [RBBau 1995]. Barrier-free construction (i.e. presents no barriers for use by handicapped or physically disabled people) is a further aspect which must be included in the assessment.

The maintenance of knowledge and skills relating to the construction and use of buildings and landholdings, as well as the provision of qualified jobs, are also socio-cultural aspects of sustainability; but these cannot be regulated within the framework of this guideline.

The external and internal impacts of a federal building present a reflection of democratic culture. The relationship with the citizens, as well as the creation of historical values can be expressed in the building's appeal and both should therefore be considered in the assessment.

These criteria are difficult to specify; they are however reflected in the specific requirements of the individual Appendices or, if necessary, in free text.

6. SUMMARY ASSESSMENT

	Planned value	Actual value	Notes
Preliminary Ecological Assessment	+ or better		
Criteria complex 1	+ or better		
Criteria complex 2	+ or better		
Criteria complex 3	+ or better		
Criteria complex 4	+ or better		
Criteria complex 5.1	+ or better		
Criteria complex 5.2	+ or better		
Criteria complex 6	+ or better		
Economical Assessment			
Construction costs			
Costs of operation and use			
Costs of building maintenance			
Socio-cultural Assessment all requirements fulfilled			
External impact/ integration into the surroundings			
Internal impact (users/visitors)			
Barrier-free construction			
Overall Rating			

Table 6.2: Overview of the Overall Assessment

The overall rating results from the equal weighting of the individual assessments. A brief explanation should be made here as to what extent the design meets or fails the sustainability criteria.

DATA BASIS

Life Span of Building Structures and Components

When making an economic and ecological assessment over the life-cycle of the building, the service life of the building components must be included in the assessment. The life expectancies indicated in the following table are based on previous experience gained over a period of time with these materials.

The actual life expectancy of the building structures and components is primarily influenced by the properties of the components, the quality of the design, the specific structural loads, and the service/maintenance. The life expectancy is therefore indicated by a range of values. The average life expectancy can be used as a guide for the assessment. The actual life expectancy may deviate from the indicated values.

The costs for inspection and maintenance, cleaning and value-preserving building maintenance are to be included in the assessment.

		Building Structures / Components	Life expectancy (from - to) [years]	Average life expectancy [years]
Load-bearing structure	1.	Concrete foundations	80 - 150	100
	2.	Exterior walls/ -columns		
		Concrete, reinforced, aired	60 - 80	70
		Natural stone, aired	60 - 250	80
		Brick, clinkers, aired	80 - 150	90
		Concrete, concrete stone, brick, limestone with facing	100 - 150	120
		Light concrete with facing	80 - 120	100
		Pointed brickwork, fair-faced brickwork	30 - 40	35
		Steel	60 - 100	80
		Softwood, aired	40 - 50	45
		Softwood, panelled; hardwood, aired	60 - 80	70
		Hardwood, panelled	80 - 120	100
	3.	Interior walls, internal supports		
		Concrete, natural stone, brick, clinker, sand-lime brick	100 - 150	120
		Light concrete	80 - 120	100
		Steel	80 - 100	90
		Softwood	50 - 80	70
		Hardwood	80 - 150	100
	4.	Ceilings, stairs, balconies		
		Concrete, aired outside	60 - 80	70

		Building Structures / Components	Life expectancy (from - to) [years]	Average life expectancy [years]
		Concrete with external or internal facing	100 - 150	100
		Vaults and caps made of brick, clinker	80 - 150	100
		Steel interior	80 - 100	90
		Steel exterior	50 - 90	60
		Load-bearing structures: internal wooden stairs, softwood	50 - 80	60
		Load-bearing structures: internal wooden stairs, hardwood	80 - 150	90
		Load-bearing structures: external wooden stairs, softwood	30 - 50	45
		Load-bearing structures: external wooden stairs, hardwood	50 - 80	70
	5.	Stairway treads		
		Natural stone, hard, external/internal	80 -150	100
		Natural stone soft, artificial stone, exterior	30 - 100	70
		Natural stone soft, artificial stone, interior	50 - 100	80
		Treads, hardwood, interior	30 - 50	45
		Treads, hardwood, exterior	20 - 40	35
	6.	Roofs, roof structures		
		Concrete	80 - 150	100
		Steel	60 - 100	80
		Timber roof structures	80 - 150	70
		Glued truss	40 - 80	50
		Nailed truss	30 - 50	30
Non-load-bearing structures, exterior	7.	Exterior walls, facings, infill walling		
		Concrete		
		- aired	60 - 80	70
		- dressed	100 - 150	120
		Natural stone, weathered	60 - 250	80
		Brick, clinker		
		- aired	80 - 150	90
		- dressed	100 - 150	120
		Sand-lime brick		
		- aired	50 - 80	65
		- dressed	100 - 150	120
		Light concrete, dressed	80 - 120	100
		Pointed brickwork	20 - 50	40

	Building Structures / Components	Life expectancy (from - to) [years]	Average life expectancy [years]
	Softwood, aired	40 - 50	45
	Hardwood, aired	60 - 80	70
8.	Airspace anchors, supporting structures		
	Steel, covered	30 - 50	35
	Stainless steel	80 - 120	100
9.	Ventilation shafts		
	Concrete, precast concrete units	40 - 70	60
	Brick, clinker	70 - 100	80
	Sand-lime brick	50 - 60	55
	Plastic	20 - 50	40
10.	Coverings to walls and roof parapets, window-sills, external		
	Natural stone	60 - 150	80
	Clinker	80 - 150	90
	Concrete, precast concrete units, ceramic, tiles, artificial stone	60 - 80	70
	Sheet copper	40 - 100	50
	Aluminium, galvanized steel, fibre cement	30 - 50	40
	Plastic	15 - 30	20
	Zinc plate, cement plaster	20 - 30	25
11.	Watertight sealing against non-pressurized water	30 - 60	40
12.	Exterior painting		
	Whitewash	6 - 8	7
	Plastic emulsion paint	10 - 25	20
	Mineral paint	10 - 25	15
	Oil and synthetic resin	5 - 20	8
	Waterproofing on masonry	15 - 25	20
	Waterproofing on wood	10 - 20	15
	Plastic coatings on concrete	15 - 30	20
13.	Exterior plaster		
	Cement plaster, lime cement plaster	20 - 50	40
	Plastic plaster	25 - 35	30
	WDVS	25 - 45	30
14.	Facing on substructure		
	Natural stone, slate, artificial stone panels	60 - 100	80
	Sheet copper	70 - 100	80

		Building Structures / Components	Life expectancy (from - to) [years]	Average life expectancy [years]
		Fiber cement panels, lead sheeting	40 - 60	55
		Aluminium	50 - 100	60
		Zinc plate, sheet steel, galvanized	30 - 60	45
		Plastic	30 - 50	40
		Glass	40 - 70	50
		Stainless steel substructure	80 - 120	100
		Steel substructure	30 - 60	45
		Wood substructure	30 - 50	35
	15.	Heat insulation, ventilated	25 - 35	30
	16.	Railing, screens, ladders, gratings, exterior		
		Stainless steel	80 - 120	100
		Aluminium, steel, hardwood	30 - 60	45
		Softwood, wood material coated	25 - 50	35
Exterior doors, -windows	17.	Frames / panels		
		Hardwood, aluminium	40 - 60	50
		Softwood	30 - 50	40
		Steel, galvanized	40 - 50	45
		Plastic	40 - 60	50
	18.	Glazing, insulation		
		Simple glazing	60 - 100	80
		Laminated insulating glass	20 - 30	25
		Cementation	8 - 15	10
		Glass sealed by sealing profile	15 - 25	20
		Glass sealed by sealing compounds (silicone etc.)	10 - 25	12
		Panel sealing profile	15 - 25	18
	19.	Fittings		
		Simple fittings	30 - 50	40
		Tilt and turn, lever tilt and turn, horizontally pivoted sash windows, sliding fittings	20 - 30	25
		Door locks	20 - 30	25
		Door closers	20 - 30	22
	20.	Solar shading - exterior		
		Fixed, made of light metal	50 - 100	60
		Moveable, aluminium or plastic	20 - 30	25
		Awnings	10 - 20	15

		Building Structures / Components	Life expectancy (from - to) [years]	Average life expectancy [years]
Non-load-bearing structures, interior	21.	Partition walls		
		Clinkers, brick, sand-lime brick, light concrete, porous concrete with plaster	80 - 150	100
		Gypsum plasterboard on substructures: - light metal, wood	35 - 60	50
	22.	Interior paint		
		Whitewash	10 - 20	15
		Distempers and plastic dispersion paint	10 - 25	15
		Mineral paint	15 - 25	20
		Oil- and lacquer coatings, latex	20 - 25	18
		Glazes, stains	10 - 15	12
	23.	Internal doors		
		Steel, softwood, fire protection grade T 30, T 90	60 - 80	70
		Whole glass	55 - 65	60
		Plywood, light metal	40 - 60	55
		Simple fittings	55 - 70	60
		Emergency locks, door closers, sliding and folding door fittings	30 - 40	35
	24.	Railings, screens, ladders, gratings: interior		
		Steel, aluminium	60 - 90	70
		Wood, wood material	50 - 80	60
	25.	Interior window-sills		
		Natural stone, ceramic, hardwood	80 - 150	100
		Softwood, aluminium, steel, plastic	30 - 60	50
	26.	Floor structures		
		Flooring under upper floor (bound-screed topping and screed topping on a partition layer)	60 - 100	80
		Screed as final wearing surface (cement-, hard- and asphaltic mastic screed)	40 - 60	50
		Floating screed	25 - 50	30
		Swing floor finish, wood	40 - 50	45
	27.	Floor coverings		
		Natural stone, hard	80 - 150	100
		Natural stone soft, artificial stone, cast stone	60 - 100	70
		Hardwood, ceramic	50 - 70	60

		Building Structures / Components	Life expectancy (from - to) [years]	Average life expectancy [years]
		Softwood	30 - 50	40
		PVC, linoleum	15 - 25	20
		Textile	8 - 20	10
		Seals, lacquer	8 - 10	8
		Waterproofing, oil, wax	3 - 5	4
	28.	Ceiling panelling, suspended ceilings		
		Wood, wood material	60 - 80	70
		Plasterboard, mineral fibre boards, plastic, aluminium	30 - 60	45
		Sub- and suspended-structures		
		- Metal	50 - 100	70
		- Wood	30 - 60	50
Non-load-bearing structures, roofs	29.	Flat roof sealings		
		Without protective coating	15 - 30	20
		With protective coating (gravel, greenery)	20 - 40	30
	30.	Roof drainage, inner		
		Inner drains made of stainless steel, plastic, cast iron	25 - 50	40
		Inner gutters, zinc plate, plastic	20 - 30	25
	31.	Light domes	20 - 30	25
	32.	Roof covering - sloping roofs		
		Zinc plate	25 - 40	35
		Fibre cement corrugated sheets, small-scale fibre cement sheets	30 - 50	40
		Roofing tiles, concrete roofing tiles	40 - 60	50
		Slate tiles	60 - 100	70
		Copper	40 - 100	50
	33.	Roof drainage, outer		
		Plastic	15 - 30	20
		Zinc plate	20 - 30	25
		Sheet copper	40 - 100	50
	34.	Heat insulation	25 - 35	30
Installations and operational facilities	35.	Water facilities		
		Ground mains, sewage mains	30 - 40	35
		Cold water pipes	30 - 60	40
		Hot water pipes	15 - 30	25
		Sanitary facilities	20 - 30	25
		Monitoring, control and regulating systems	12 - 15	10

		Building Structures / Components	Life expectancy (from - to) [years]	Average life expectancy [years]
	36.	Heating systems		
		Fuel containers	15 - 30	20
		Heater and blowing unit	10 - 20	12
		Central water heater; boiler	15 - 25	20
		Geothermal heat exchanger	50 - 80	60
		Pumps, motors, heat pumps	10 - 15	12
		Heating pipes	30 - 50	40
		Heating surfaces and fittings	20 - 30	25
		Monitoring, control and regulating systems	10 - 15	12
	37.	Ventilation and air-conditioning (VAC) systems		
		VAC devices	10 - 20	15
		VAC - cooling plant	10 - 25	15
		Heat recovery plant	15 - 25	20
		Filter plant, general	12 - 20	15
		Monitoring, control and regulating plant	10 - 20	15
		Air ducting networks	30 - 40	35
	38.	Electricity - high voltage power plant		
		High and medium tension circuitry	20 - 30	25
		Transformers	20 - 30	25
		Low voltage systems	20 - 30	25
		Lines, cables, distribution systems	20 - 30	25
		Switches	10 - 20	15
		Lightning conductors	20 - 30	25
		Monitoring, control and regulating plant	10 - 20	15
	39.	Elevator facilities	20 - 35	30
Outdoor facilities	40.	Enclosures, fences, palisades, barriers, gates		
		Softwood, waterproof	15 - 25	20
		Hardwood	25 - 35	30
		Metal - galvanized, plastic coated	30 - 40	35
		Precast concrete units	60 - 80	70
	41.	Sewage mains, gulleys, manholes, structures		
		Mains:		
		- Stoneware	80 - 100	90
		- Concrete, reinforced concrete (foul water)	50 - 100	70

		Building Structures / Components	Life expectancy (from - to) [years]	Average life expectancy [years]
		- Concrete, reinforced concrete (rainwater)	50 - 100	60
		- In-situ concrete with inner lining	80 - 100	90
		- Plastic	40 - 50	45
		Manholes, structures		
		- Concrete	60 - 80	70
		- Sewer bricks	80 - 100	90
		- Precast plastic units	40 - 50	45
		Manhole covers		
		- Cast iron	60 - 100	80
		- Reinforced concrete	40 - 60	50
	42.	Traffic facilities: pathways, streets, surfaces suitable for traffic, courtyards, vehicle parking areas		
		Concrete pavement	20 - 30	25
		Asphalt pavement	15 - 25	20
		Paved surfaces		
		- Natural stone, hard	80 - 150	100
		- Concrete, clinkers, artificial stone slabs, soft natural stone on a soft foundation	20 - 40	30
		- Concrete, clinkers, artificial stone slabs, soft natural stone on concrete foundation	40 - 60	50
	43.	Lighting of external facilities		
		Lighting columns, lighting cable ducts		
		- Cast iron, galvanized steel, aluminium	30 - 40	35
		- Stainless steel	60 - 100	80
		Wires		
		- Steel, rust-free	60 - 80	70
		- Plastic, glass-fibre reinforced	40 - 60	50
		Lighting fixtures	20 - 30	25
		Ground cables	20 - 30	25
		Switch cabinets and clocks	12 - 18	15

Table 6.3: Life Expectancy of Building Components / Elements (based on [SIA D0123], [IEMB 1998], [BMBau 1994], [LBB 1995], [Wert R 91], [VDI 2067] and [IPBau 1994]

Characteristic Costs for Building Utilisation and Operation

So far only a limited data basis, related to various measurements of reference areas, has become available. This means that only general estimates can be made and these are likely to contain some inaccuracies.

The costs to be expected for a specific design project should therefore be determined by reliable indicative calculations based on recognised procedures and taking into consideration the requirements of Appendix 4.

The data used in the following are based on estimates derived from available designs drafts and data collected and prepared by various public bodies (e.g. State Building Administration Baden-Württemberg, the Federal Bureau of Building and Regional Planning, State Building Administration NRW, the Energy Industry Consultation Office of the OFD, Frankfurt a. M. and others). The sources of the information are given in the tables. The data basis is being constantly updated.

7.2.1 Capital Costs, Amortisation, Administration Costs and Taxes

These cost groups should only be determined in relation to each particular building and are also not relevant to issues of ecology or energy. Therefore there are no set figures for characteristic costs here. Nonetheless, costs for this cost group should be included in the building utilisation costs when making an overall assessment of economic efficiency.

7.2.2 Building Utilisation Costs

Building-related Costs of Cleaning the Building

Type of Building 1) Costs - as for 1996	Characteristic Cost Values Guideline value (€/m² · year) per m² HNF	m² BGF	Target value (€/m² · year) per m² HNF	m² BGF	Source
High quality administration buildings (e.g. parliament / government buildings)	16,80	7,20	11,80	5,10	[BBR 93-95]
Administration buildings, general	13,80	5,90	9,70	4,10	[ZBWB]
Court buildings					
Institutional buildings for education and research					
Hospitals					
Schools					
Nursery schools					
Sports facilities					
Residential buildings					
Workshops					
Buildings used for cultural purposes					
Penal institutions					
Miscellaneous					

will be completed

Table 6.4: Building Cleaning Costs according to Building Type

1) Building type definition as in [LAGDAT 1998]

As a basis for the partial optimisation at the level of building components, the following table gives indicative values for the cleaning costs of the main building components (floorings and facades).

Flooring Material	Daily cleaning	Intensive cleaning
Polished granite [1)]	100	100
Artificial stone	102	105
Synthetic resin bound stone	102	100
Natural stone (polished)	102	100
Linoleum	105	130
PVC	105	130
Fitted carpets	110 (90 to 140)	200
Tiled flooring (glazed)	110	125
Tiled flooring (non-glazed)	120	135
Smooth rubber flooring	120	115
Natural stone (rough)	120	125
Sealed wooden flooring	120	[2)]
Knobbed rubber flooring	150	150

Table 6.5: Floor Cleaning - Indicative Values of the Costs [BATELLE 1991]

[1)] Polished granite is usually used as a reference material by the cleaning industry.
[2)] Sand down and resealing.

Material used for the facades		House type two-storey		House type ten-storey	
		Cycle years	Index	Cycle years	Index
1	Aluminium-cladding				
1.1	Surface anodic-oxidized (polished)	2	700	1	1600
1.2	Surface coated	2	310	2	400
1.3	Surface band coated	2	310	2	400
2	Enamelled sheet steel facing	1	310	1	400
3	Glass facing				
3.1	Rear enamelled	1	440	1	240
3.2	Rear enamelled and metal oxide coated	0.25	1750	0.25	960
4	Fibre cement slabs				
4.1	Large format	2	310	2	200
4.2	Small format	10	380	-	-
5	Facing out of copper	-	-	-	-
6	Facing out of zinc	3	470	-	-
7	Facing out of natural stone				
7.1	With open joints	20	100	20	100
7.2	With closed joints	20	100	20	100
8	Facing out of artificial stone with facing	12	680	12	1280
9	Clinker layer, cavity wall	20	420	20	620
10	Large format precast concrete units	12	680	12	1280
11	Facing out of wood or wooden materials 1)				
11.1	Solid wooden panelling, completely coated	5	170	-	-
11.2	Solid wooden panelling, heartwood, uncoated	10	20	-	-
11.3	Special façade panels out of wooden materials	10	100	-	-

Table 6.6: Cleaning of Facades - Cleaning Cycles and Indicative Values of Costs [BATELLE 1986]

1) German Association on Timber Research (DGFH)

Operation, Maintenance, Inspection

Type of Building 1)	Characteristic Cost Values				Source
	Guideline value (€/m^2 · year) per		Target value (€/m^2 · year) per		
	m^2 HNF	m^2 BGF	m^2 HNF	m^2 BGF	
High quality administration buildings (e.g. parliament / government buildings)	11,50	5,00	8,00	3,50	[BBR 93-95]
Administration buildings, general					
Court buildings					
Institutional buildings for education and research					
Hospitals					
Schools					
Nursery schools					
Sports facilities					
Residential buildings					
Workshops					
Buildings used for cultural purposes					
Penal institutions					
Miscellaneous					

Table 6.7: Costs of Building Operation, Maintenance and Inspection according to Building Type

Miscellaneous

The values for "Miscellaneous" include the maintenance of traffic and green areas, waste disposal, building fire insurance, building security etc. An indicative value is to be prepared for traffic and green areas, based on the m^2 of outdoor facilities. At the present time however, the necessary information for this is lacking.

Type of Building	Characteristic Cost Values Guideline value (€/m² · year) per		Target value (€/m² · year) per		Source
	m² HNF	m² BGF	m² HNF	m² BGF	
High quality administration buildings (e.g. parliament / government buildings)	10,10	4,40	7,10	3,10	[BBR 93-95]
Administration buildings, general	9,00	3,90	6,30	2,70	[ZBWB]
Court buildings					
Institutional buildings for education and research					
Hospitals					
Schools					
Nursery schools					
Sports facilities					
Residential buildings					
Workshops					
Buildings used for cultural purposes					
Penal institutions					
Miscellaneous					

will be completed

Table 6.8: Miscellaneous Costs according to Building Types

7.2.3 Building Maintenance Costs (not including changes in use)

Type of Building	Characteristic Cost Values				
	Guideline value (€/m² · year) per		Target value (€/m² · year) per		
	m^2 HNF	m^2 BGF	m^2 HNF	m^2 BGF	Source
High quality administration buildings (e.g. parliament / government buildings).	14,00	6,00	9,80	4,20	[BBR 93-95]
Administration buildings, general					
Court buildings					
Institutional buildings for education and research					
Hospitals					
Schools					
Nursery Schools					
Sports facilities					
Residential buildings					
Workshops					
Buildings used for cultural purposes					
Penal institutions					
Miscellaneous					

will be completed

Table 6.9: Costs of Building Maintenance

Hot Water-Utilisation Rates

	Utilisation rate	As factor
Oil-fuelled boiler / gas-fuelled boiler with reservoir	45%	2.22
Oil-fuelled boiler / gas-fuelled boiler with through flow water heating	60%	1.7
Oil/natural gas heated reservoir	50%	2
Gas-fired through flow heater with ignition flame	60%	1.7
Gas-fired through flow heater without ignition flame	80%	1.25
Circulating gas-fired water heater	70%	1.43
District heating, storage system	85%	1.18
District heating, through-flow system	95%	1.05
Electricity storage, off-peak electricity	70%	1.43
Electrical through-flow water heater	95%	1.05
Heat pump reservoir	150%	0.67
Solar collector with 50% additional electrical heating	150%	0.67

Table 6.10: Hot Water-Utilisation Rates [TBHK], Page 1767

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Appendix 7

BUILDING CERTIFICATION

Note:

The Building Certification comprises important operational notes and characteristic values for buildings in the form of a building handbook and inventory. It is of special relevance to the utilisation (operational) phase of the building and for the documentation of the building's history (important when planning for building conversion or demolition work). It also records the key data collected during the initial design process.

Since reference values for consumption are a forecast, deviations should be expected if they are applied without reference to actual costs and levels of consumption!

BUILDING CERTIFICATION

0.

General Information

Location of the building (address): ....

....

Client / building contractor: ....

....

Owners:
1. ....
2. ....
3. ....

Designer: ....

Date of completion (as per VOB): ....

Date of acceptance by lower building inspectorate: ....

Date of modernisation / renovation: ....

Building certification prepared on: ....

by: ....

additions made on: .... by: ....

additions made on: .... by: ....

additions made on: .... by: ....

Enclosures

☐ List of design experts

☐ List of companies undertaking the work

☐ ....

1. Planning Laws and Building Regulations

☐ Land use plan available

Zoning plan: no. / date ....

☐ Liabilities / restrictions in force

Building permit issued on: ....

Important terms and conditions: ....

....

....

Dimension of structural use

GFZ: permitted .... available

GRZ: permitted .... available

Special regional requirements: ....

....

....

....

Protection of historic monuments: ....

....

....

....

Enclosures

☐ Excerpt from the development plan

☐ ....

Landholding

District: ....

Land parcel: ....

Section of land parcel: ....

Total area: ....

Liabilities / restrictions

Former use of the property: ....

Share of sealed areas: ....

☐ Contaminated site present

☐ Contaminated site suspected

Development Access

☐ Water .... [m³/h]; .... [bar]

☐ Sewage
(discharge quantity):

☐ Foul water: ....

☐ Rainwater: ....

☐ Electricity: .... [kW]; .... [V]

☐ Gas: .... [m³/h]; .... [bar]

☐ District heating: .... [kW]; .... [K]

☐ Communication
(type of connection): ....

Distance to local public
transport system: ....

Other: ....

Enclosures

☐ Location Plan

☐ ....

3. Outdoor Facilities

☐ Terraces available

☐ Access ways and approaches available

☐ Requirements of "freedom from barriers" satisfied

☐ Enclosures: type: ....

☐ Waste collection area available

☐ Rainwater seepage system available

Utilities supply and disposal mains (section, material):

Water: ....

Sewage: ....

Rainwater: ....

Foul water: ....

☐ Sewage pump station ....

Electricity:

High voltage: ....

Telephone: ....

TV: ....

Lighting: ....

Number of parking spaces: ....

Number of garage spaces: ....

☐ Green spaces available

Plants: ....

☐ Playgrounds available

Sports facilities: ....

Enclosures

☐ Building description - outdoor facilities

☐ Property-related sewage disposal concept (LAK)

☐ ....

Buildings

General Description

Gross volume (BRI): .... [m^3]

Converted volume: .... [m^3]

Number of storeys: .... [storeys]

Residential units:
Number / type / size ....

....

Offices :
Number / type / size ....

....

Other uses (laboratory,
lecture halls etc.):
Number / type / size ....

....

Areas:
Gross floor area (BGF): .... [m^2]

Net floor area (NGF): .... [m^2]

Useable floor area (NF): .... [m^2]

Operation area (FF): .... [m^2]

Main utilisation area (HNF): .... [m^2]

Residential area: .... [m^2]

A/V ratio: ....

BRI/BGF ratio: ....

Basement:

☐ Full basement

☐ Partial basement

Enclosures

☐ Ground Plan ☐ Elevations

☐ ....

4.2 Building Construction (brief description)

Site subsurface: ....

Groundwater: ....

Stratum water: ....

Foundations: ....

External walls of the basement: ....

External walls: ....

Load-bearing internal walls: ....

Partition walls: ....

Ceilings: ....

Stairways: ....

Roof: ....

Windows: ....

Doors: ....

Sun protection / sight protection: ....

Enclosures

- ☐ Excerpt from the geological survey
- ☐ Property and building book
- ☐ Building description
- ☐ ....

Stability / Load-bearing Capacity

4.3

Allowable service loads:

Offices: .... [kN/m²]

Residential areas: .... [kN/m²]

Conference rooms: .... [kN/m²]

Corridors: .... [kN/m²]

Stairways: .... [kN/m²]

Fire Protection

4.4

☐ No special requirements

Special safety requirements: ....

....

....

....

....

Enclosures

☐ Short description of the static system

☐ Note on the static analysis and documents provided; seismic safety

☐ ....

☐ Fire protection concept

☐ ....

4.5 Use of Daylight / Artificial Lighting

Proportion of windows: .... % of the area of the outer facades

Intensity of illumination and specific connecting power output

Offices: .... lx with .... [W/m²]

At the workplace: .... lx with .... [W/m²]

Conference rooms: .... lx with .... [W/m²]

Connecting areas:

Corridors : .... lx with .... [W/m²]

Stairways: .... lx with .... [W/m²]

Underground parking: .... lx with .... [W/m²]

Distribution of luminance between workplaces and the surrounding area:

....

....

Enclosures

☐ Lighting concept

☐ ....

Heat Protection / Energy Requirement

Annual heating energy requirement
(forecast consumption based on EnEV)

.... [kWh/(m²HNF per year)]

.... [kWh/(m²BGF per year)]

.... [kWh/(m²Wfl. per year)]

Primary energy requirement

☐ Requirements of the Energy Conservation Act (EnEV) satisfied

☐ Exceeded by.................... %

☐ **Measures for summertime heat insulation**

Type: ....

Characteristic value for incident sunlight

Relevant maximum value according to DIN V 4108-2 (2000) ....

Values calculated for the building:

Building component: .... s: ....

Building component: .... s: ....

☐ Cooling available

Electricity requirement: .... [kWh/(m²HNF per year)]

.... [kWh/(m²BGF per year)]

Use of renewable forms of energy

Type / share: .... / .... [%]

.... / .... [%]

Enclosures

☐ Energy supply concept
☐ Evidence of energy requirement
☐ Certified as per EnEV
☐ Certificate of heating requirement *)
☐ Verification of heat insulation with analysis of areas and of characteristic value *)

*) obligatory, as long as the Regulation on Heat Insulation is still in force

☐ Verification of summertime heat insulation
☐ Cooling load calculation
☐ Certificate showing the electricity requirement, where this is not already considered by the evidence provided in respect of the Energy Conservation Act.
☐ Explanation of the concept for use of renewable forms of energy and level of annual consumption / number of installations, where this is not already included by the evidence provided in respect of the Energy Conservation Act.
☐ ....

4.7 Sound Protection

	required	actual value
Protection against noise coming from other rooms		
Airborne sound insulation (assessed level of sound insulation)		
Interior walls .... [dB]	....	....
Ceilings .... [dB]	....	....
Doors .... [dB]	....	....
Footstep sound insulation (assessed standard level of footstep sound)		
Ceilings .... [dB]	....	....
Stairways .... [dB]	....	....
Protection against outdoor noise		
Airborne sound insulation (evaluated level of sound insulation)		
External walls .... [dB]	....	....
Windows .... [dB]	....	....
Doors .... [dB]	....	....
Resulting level of noise insulation (external building components) .... [dB]	....	....
Roof .... [dB]	....	....
Protection against noise derived from building installations		
Water systems:		
Installation sound level .... [dB(A)]	....	....
Other building installations:		
Maximum sound pressure level .... [dB(AF)]	....	....

Enclosures

☐ Evidence of sound protection ☐ ....

Ventilation

4.8

Free ventilation

☐ Transverse ventilation

☐ Shaft ventilation

Mechanical ventilation

☐ Ventilation

Aeration and ventilation

☐ with recovery of heat

☐ without recovery of heat

Open air rates

Working areas

Single offices: ....(m^3/h pers.); ....($m^3/h \cdot m^2$)

Open-plan offices: ....(m^3/h pers.); ....($m^3/h \cdot m^2$)

Conference rooms: ....(m^3/h pers.); ....($m^3/h \cdot m^2$)

Residential units: ....($m^3/h \cdot m^2$)

Water Consumption

4.9

Water consumption .... l/year

Water consumption .... l/(m^2 per year)

Water consumption .... l/(pers. per year)

Enclosures

☐ Explanatory notes on the ventilation concept and characteristic values for energy gained and auxiliary energy used

☐ ....

☐ Water conservation concept

☐ ....

4.10 Waste Treatment

Waste disposal facility: ....

....

....

4.11 Equipment and Furnishings

☐ Elevator

☐ Underground parking

☐ Barrier-free accesses

Special user-friendly furnishings and equipment: ....

....

....

Floor coverings: ....

Surfaces

Walls: ....

Ceilings: ....

Installations: ....

....

....

Enclosures

☐ Waste disposal concept

☐ ....

☐ Explanatory notes on room furnishings and equipment (coatings/surfaces of floors, walls, ceilings, stairways, doors, installations)

☐ Description of sanitary facilities and kitchen furnishings

☐ ....

TGA

Electrical plant

☐ Cabling of empty pipes

☐ Installation of cables on the outer surface of walls

Short description of electrical plant: ....

Telecommunications system

☐ Cabling of empty pipes

☐ Installation of cables on the outer surface of walls

Short description of telecommunications system: ....

Heating

Type / type of plant ....

Boiler: ....

Heat distribution: ....

Heating medium: ....

Radiators: ....

Hot water systems

☐ Centralised

☐ Decentralised

Short description of hot water system: ....

Sanitary facilities

Type / pipe materials: ....

Fittings: ....

Short description of sanitary facilities: ....

Ventilation system

Short description: ....

Sewage plant

Foul water ....

Rainwater ....

☐ Pump station available

Short description of sewage plant: ....

Plant for the use of regenerative energy

Short description: ....

Enclosures

☐ Description of electrical plant

☐ Description of telecommunications system

☐ Description of heating plant

☐ Description of hot water system

☐ Description of sanitary facilities

☐ Description of ventilation system

☐ Description of sewage plant

☐ Description of system for using regenerative energy

☐ ....

5. Inspection / Servicing / Maintenance

Plant / building components		**Intervals [year]** Insp.	Serv.	Maint.
Elevator systems:	....	....	....	....
Electrical plant:	....	....	....	....
Telecommunications system:	....	....	....	....
Heating system:	....	....	....	....
Hot water plant:	....	....	....	....
Sanitary facilities:	....	....	....	....
Ventilation plant:	....	....	....	....
Sewage plant:	....	....	....	....
Plant for the use of regenerative energy:	....	....	....	....
Load-bearing structures:	....	....	....	....
Roof:	....	....	....	....
Facade:	....	....	....	....
Windows / doors:	....	....	....	....
Floors:	....	....	....	....
Outdoor facilities:	....	....	....	....
Other:	....	....	....	....

Enclosures

☐ Explanatory notes on the intervals between service and maintenance works

☐ Documentation of maintenance measures

☐ ....

Management Costs

	Costs [€/year]			
	1st year of use	succeeding years		
Cleaning of the building				
Water / Sewage				
Heating / Cooling				
Electricity				
Operation, maintenance, inspection				
Building maintenance				
Other:				
....				
....				
....				

Enclosures

☐ Summary of expected utilisation costs (including energy and water consumption, cleaning, maintenance of outdoor facilities)

☐ ....

LIST OF ABBREVIATIONS

Abbrevation	German	English
A	Fläche	Area
AbfKoBiV	Abfallwirtschaftskonzept- und -bilanzverordnung	Regulation on Waste Management Concept and Waste Balancing
AMEV	Arbeitskreis Maschinen- und Elektrotechnik staatlicher und kommunaler Verwaltungen	Government and local authorities "Mechanical and Electrical Engineering Working Group"
AOLG	Arbeitsgemeinschaft der obersten Landesge-sundheitsbehörden	Committee of the Superior State Working Health Administrations
ARGEBAU	Bauministerkonferenz	Conference of Building and Construction Ministers
ASR	Arbeitsstättenrichtlinie	Regulation on places of work
BGA	Bundesgesundheitsamt	Federal Department of Health
BGBl.	Bundesgesetzblatt	Federal Law Gazette
BGF	Bruttogesamtfläche	Gross floor area
BHO	Bundeshaushaltsordnung	Federal Budget Regulation
BImSchG	Bundes-Immissions-schutzgesetz	Federal Immission Control Law
BMF	Bundesministerium der Finanzen	Federal Ministry of Finance
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit	Federal Ministry of Environment, Natural Protection and Reactor Safety
BMVBW	Bundesministerium für Verkehr, Bau- und Wohnungswesen	Federal Ministry of Transport, Building and Housing
BMVg	Bundesministerium für Verteidigung	Federal Ministry of Defense
BRI	Brutto-Raum-Inhalt	Gross volume
CEN/TC	Europäisches Komitee für Standardisierung / Technisches Komitee (Comité Européen de Normalisation/Comité Technique)	European Standardisation Committee/Technical Committee
dB	Dezibel	Decibel
DIN	Deutsches Institut für Normung (= Regeln der Technik)	German Standardisation Institute (= Technical Regulations)
DIN EN	DIN Europäische Norm	DIN European Standard
DIN prEN	DIN Europäische Norm (Entwurf)	DIN European Standard (Draft)
DM	Deutsche Mark	German Mark
DVGW	Deutscher Verein des Gas- und Wasserfaches	German Association for Gas and Water Technology
EnEV	Energieeinsparverordnung	Energy Conservation Act
FF	Funktionsfläche	Operation area
GED	Gemeinschaft Energielabel Deutschland	Energy Label Association, Germany
GefStoffV	Gefahrstoffverordnung	Regulation on hazardous substances
GFZ	Geschossflächenzahl	Number of storeys
GLT	Gebäudeleittechnik	Central building control systems
GRZ	Grundflächenzahl (Gebäudegrundfläche je m² Grundstücksfläche)	Number of building plots (building plot area per m² property area)
HeizAnlV	Heizanlagenverordnung	Regulation on Heating Systems
HNF	Hauptnutzfläche	Main Utilisation Area
HOAI	Honorarordnung für Architekten und Ingenieure	Regulation on fees for architects and engineers
HVAC	Heizungs- und Lüftungssystem	Heeting and Ventilation and Air-conditioning system
IEMB	Institut für Erhaltung und Modernisierung von Bauwerken e. V.	Institute for the Preservation and Modernisation of Buildings

Abbrevation	German	English
ifib	Institut für industrielle Bauproduktion	Institute for Industrial Building Production
IRK	Innenraumlufthygiene-Kommission	Indoor air hygiene commission
ISI	Institut für Systemtechnik und Innovationsforschung (Fraunhofer Gesellschaft)	Institute for System Theory and Innovation Research (Fraunhofer Association)
ISO	Internationale Organisation für Standardisierung	International Organisation for Standardisation
kN	Kilo Newton	Kilo newton
LAK	Liegenschaftsbezogenes Abwasserentsorgungskonzept	Property-related sewage disposal concept
lx	Lux	Lux
NachwV	Nachweisverordnung	Regulation on verification procedures
NF	Nutzfläche	Useable floor area
NGF	Nettogrundfläche	Net floor area
NRW	Nordrhein-Westfalen	North-Rhine-Westphalia
OFD	Oberfinanzdirektion	Supervising Department of Finance
PCB	Polychlorierte Biphenyle	Polychlorinated Biphenyles
PMV	Index für das persönliche Wohlbefinden (Maß für das thermische Empfinden des Menschen in seiner atmosphärischen Umgebung - EN ISO 7730)	Index for personal well being, (dimension for the thermal sensation of human beings in their atmospheric surrounding - EN ISO 7730)
PPD	(kleinstmöglicher) Prozentsatz Unzufriedener bzgl. thermischer Behaglichkeit (EN ISO 7730)	Minimal percentage of dissatisfied persons, regarding thermal comfort (EN ISO 7730)
RAL	Deutsches Institut für Gütesicherung und Kennzeichnung e. V.	German Institute for Quality Assurance and Labelling e.V.
RBBau	Richtlinien für die Durchführung von Bauaufgaben des Bundes im Zuständigkeitsbereich der Finanzbauverwaltung	Regulations for the Execution of Federal Building Projects under the Jurisdiction of the Building Financial Administration
RLT	Raumlufttechnik	Ventilation and air conditioning engineering (VAC)
RStO	Richtlinien für die Standardisierung des Oberbaus (Straßenbau)	Guidelines for standardisation of road pavements (road construction)
SIA	Schweizerischer Ingenieur- und Architektenverein	Swiss Association of Engineers and Architects
STU	Stammumfang	Trunk girth
TA Luft	Technische Anleitung Luft	Technical instructions on air quality
TGA	Technische Gebäudeausstattung	Technical building installations and equipment
TVOC	flüchtige organische Verbindungen	Total volatile organic compounds
UBA	Umweltbundesamt	Federal Department of the Environment
V	Volumen	Volume
VDI	Verein Deutscher Ingenieure	Association of German Engineers
v. H.	von Hundert	Of hundred
VOB	Verdingungsordnung für Bauleistungen	Contract Regulations for Building Services
W	Watt	Watt
WDVS	Wärmedämm-Verbundsystem	Heat insulation grid system
Wfl.	Wohnfläche	Residential area