STANDARD
ATV - A 106E

Design and Construction Planning
of Wastewater Treatment Facilities

October 1995
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ISBN 3-934984-02-9
This ATV Standard has been produced by the ATV Specialist Committee "Design and Construction of Sewage Treatment Plants" and Working Group 2.11.1 "Hydraulic Calculation of Sewage Treatment Plants". The following members belong to both bodies:

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Original German edition produced by: JF•CARTHAUS GmbH & Co, Bonn
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Notes for Users

This ATV Standard is the result of honorary, technical-scientific/economic collaboration which has been achieved in accordance with the principles applicable (statutes, rules of procedure of the ATV and ATV Standard ATV-A 400). For this, according to precedents, there exists an actual presumption that it is textually and technically correct and also generally recognised.

The application of this Standard is open to everyone. However, an obligation for application can arise from legal or administrative regulations, a contract or other legal reason.

This Standard is an important, however, not the sole source of information for correct solutions. With its application no one avoids responsibility for his own action or for the correct application in specific cases; this applies in particular for the correct handling of the margins described in the Standard.

Foreword

Water pollution control presents all those concerned with comprehensive tasks which are only to be solved through interdisciplinary organisation. ATV, the German Association for the Water Environment, has tasked its Specialist Committee 2.11 "Design and Construction of Sewage Treatment Plants", to make the complex procedures of modern planning clearer and more easy to grasp by means of an ATV Standard. The recommendations produced by the committee apply basically for all wastewater treatment facilities. With the design and construction of systems for the treatment of industrial wastewater special aspects have, if necessary, to be taken into account.

The Standard is to provide a framework for the necessary considerations and engineering tasks with the design and construction of sewage treatment plants; this applies analogously for other wastewater treatment facilities. The necessary activities equally concern planners, construction sponsors and approving authorities. The necessity for the correct planning of wastewater treatment facilities arises from statutory specifications, and places on each form of wastewater disposal organisation a responsibility which is not to be circumvented. Only qualified and experienced specialists should be tasked with the production of planning documents.

The result of the work of the specialist committee is the presentation of the complete planning, financing, approval and implementation activities as well as the time sequence and interdependence of all important individual activities.

The Standard is divided into four main sections:

Design
Construction planning
Additional information on important individual tasks
Logic diagram.

This Standard is not to be seen as a performance specification for the contractual processing of the planning and construction management tasks of planning and supervisory engineers and therefore deliberately follows neither a systematic form nor the terms for the performance descriptions of the German Regulations for Professional Fees for Architects and Engineers (HOAI), which applies for all fields of engineering. This HOAI is important for the engineering services with the planning and construction of wastewater treatment facilities insofar as it regulates the services to be provided and their remuneration.

The performance of planning and construction management engineers are differentiated according to the HOAI into so-called "Basic services" and into "Special services", which are necessary for a successful project. Many of the engineering services described in this Standard are not included in the "Basic services" of the HOAI; they are "Special services" within the meaning of § 2 HOAI and supplement and
expand the performance contents of the basic services. The consideration of whether they are necessary or not must be carried out in the individual case. Furthermore, the HOAI system in "Object planning" and "Specialist planning", whereby, for example, the special contributions of the specialist planner for operational and process engineering, the technical fitting out of buildings and engineering structures, the supporting framework planning, the landscape planning etc. are to be seen as specialist planning contributions. Even this differentiation into object planning and specialist planning is not adopted in the Standard, particularly as the HOAI and its contents are subject to continuous up-dating.

With this Standard there is deliberately no elaboration of the specialist fulfilment of the HOAI, rather the difficult and extensive dependencies and activities of the various participants in the planning and construction of a wastewater system are presented in an interdisciplinary way. The user of the HOAI is not relieved of working out, case by case, the services and the performance limitations for the planning and construction engineer from the HOAI, their official justification and the numerous available commentaries on the HOAI. This Standard can and will not, from the aspect of contents, the determination of services in accordance with the HOAI, rather it is designed to ensure the quality of planning and construction supervision with the building of wastewater treatment facilities, independent of a framework of professional fees.

The contents of the various (German) Federal State directives on design and construction planning remain unaffected.

With the publication of this Standard, ATV Standard ATV-A 106 from 1962 "Advisory Leaflet for the Planning of a Sewage Works" (New edition in 1971 with unchanged text) is replaced.

1 Design

Preamble

Preliminary studies, investigations, initial planning and approval planning are to be agreed between planner, construction sponsor and the approval authorities. The respective subsequent processing stage should, as far as possible, only begin after successful agreement.

The design of wastewater treatment facilities must take account of the effects of construction and operation on other areas of the environment. The assessment must include comprehensively the environmental effects, in particular with regard to residence and recreation as well as to flora and fauna. In the interest of transparency of the decision process, it is recommended that the assessment is carried out in an independent environmental compatibility study with cost comparison in parallel to and in close association with the technical planning. If, for reasons of statutory specifications, an environmental compatibility examination is to be carried out, the authorities responsible for this should be engaged at an early date. It is to be established in what manner and in which scope the statutory requirements have to be taken into account.

The planning documents are to be produced taking into account the generally accepted rules of technology and, in special cases (e.g. industrial wastewater), according to the status of technology. Generally accepted rules of technology are, for example, DIN/Euronorms, technical rules and standards (ATV, DVGW), safety regulations, construction regulations etc.
1.1 Preliminary Findings

1.1.1 (German) Federal and Federal State Regulations

Regulations under water law and charges law of the Federal Republic and of the Federal States, in the respective valid version, are binding for design and construction planning. Federal Republic legal requirements apply in particular to:

- Water Resources Management Law (WHG)
- Water Charges Law (AbwAG)
- Waste Law (AbfG)
- Federal Immission Protection Law (BimschG)
- Law on the Environmental Compatibility Examination (UVPG)
- Federal Conservation Law (BnatSchG)
- Federal Waterways Law (WaStrG)

The Federal States, through their own laws, fill in the laid down framework and, in addition regulate such areas, which lie outside Federal competence.

Water Law also applies, inter alia to wastewater disposal. Thus the requirements on the construction and operation of wastewater facilities are formulated and prerequisites for the discharge of wastewater given. The Federal States and, in individual cases, offices determined by them, are authorised by the Water Law to carry out overlapping water management and wastewater technical planning. As far as appropriate plans are produced, the constraints for the design and construction planning of wastewater treatment facilities are derived from these. Thus it is to be ensured that human beings and the environment are not unlawfully interfered with by the construction and operation of the wastewater treatment facilities. In particular, the following are to be observed:

- general water resources plans - § 36 WHG
- control plans - § 36 b WHG
- wastewater disposal plans - § 18 a WHG
- minimum requirements - § 7 a WHG
- pollution abatement orders - § 27 WHG
- Wastewater Sources Ordinance - AbwHerkV
- Indirect Discharger Ordinance - IndVo
- Federal State Water Laws - LWG
- Federal State Waste Laws - LAG
- Technical Directive Municipal Waste (TA Siedlungsabfall)
- Technical Directive Special Waste (TA Sonderabfall)
- Sewage Sludge Ordinance - AbfKlärV
- Technical Directive Air (TA Luft)
- Technical Directive Noise (TA Lärm)
1.1.2 Other Regulations and Specifications

Regional and area development plans of the (German Federal States)

The production of these "regional plans" falls to the regional planning bodies. The plans contain the aims of regional and federal state planning for the long-term overall development of the planning region and a firm representation of the aspired development. In the plans, inter alia, the current conditions, the planning and the intended measures in the areas of water, agriculture and forestry, traffic routes, residential and municipal matters etc. are shown.

Construction management planning

In accordance with the Construction Code (BauGB in the respective valid edition) the municipalities are responsible for the construction management planning (land development plan and building plan). The municipalities have to produce these plans matched to the aims of the regional and federal state planning, as soon as and as far as the are necessary for the urban development. In particular the concerns of environmental protection are also to be taken into account here (UVPG).

Municipal regulations

The municipal wastewater bylaws are to be observed, inter alia, with regard to the permitted limiting values for the discharge of wastewater into the public sewer system.

Assets and development

Determinations are to be made on:

- existing drainage and wastewater treatment facilities as well as possibly existing planning
- status and development of the population, commerce, industry and agriculture.

Discharge possibilities

Given data on water regime and water levels of the receiving waters as well as their loading capacity and usage are to be adopted. Regulations under water law and others, anticipated constraints on the discharge of wastewater into the receiving water as well as immission protection requirements must be investigated.
1.1.3 Preliminary Studies and Investigations

Sewer network

Wastewater treatment facilities and sewer systems form a wastewater engineering unit. Planning alternatives must take account of this.

Individual/group sewage treatment plants

For these decisions are made, inter alia, from the following aspects:

- legally binding specifications from wastewater disposal plans (concepts)
- assessment of the indirect discharger cadastre (register)
- effects on lakes and rivers
- interference with nature and the countryside
- dimensions and population density of the catchment area
- dimensions and operational safety of the treatment plants
- arrangement of stormwater overflows and stormwater overflow tanks
- control
- operational advantages and disadvantages
- overall economic advantages and disadvantages
- treatment of residues
- treatment requirements.

Questions of location

Local and regional prerequisites must be taken into account with the agreement on the location, in particular separation from buildings, wind conditions, type of buildings, possible contaminated sites, possibilities for the supply of electricity, if required also of gas and water, site development, traffic facilities, feed and discharge of wastewater, safety against flooding and water protection areas. Should the occasion arise, a subsoil reconnaissance is necessary so that, with the production of the initial draft, there is already first information on possible foundations.

With the siting of a wastewater treatment facility in the countryside the criteria of conservation and of care of the landscape are of great significance. In § 8, Para 2 of the German Federal Conservation Law - BNatSchG - of 12.03.87, it is stated that persons who occasion an impairment are to be obliged to make good avoidable as well as unavoidable impairments within a certain period of time, through measures of conservancy and care of the landscape, so far as this is necessary to achieve the aims of conservancy and care of the landscape. Use of the countryside is to be minimised.

As a whole, the environmental compatibility of the project at the planned location, including variants, is to be investigated already in this early stage.

Disposal of residual matter

The correct disposal (utilisation) of all residual matter resulting from the treatment of wastewater such as, for example, screenings and grit chamber products, sewage sludge, if necessary outside sludge which has to be treated jointly etc., demands particular attention. Here, local and regional possibilities frequently influence the selection of the process and the location for the treatment and disposal of residual matter.
Expansion measures

Expansion measures as a rule involve massive interference with the existing substance of buildings and with the operation of a sewage treatment plant. The water management significant rebuilding phases are to be shown in the plans for rebuilding and commissioning. These construction phase plans should contain a schematic representation of existing or already provided plant components and diversions and/or connection pipelines with details of the direction of flow.

Appropriate operating phase plans are necessary to ensure the treatment performance of the sewage treatment plant during the rebuilding period. In addition details on the maintenance of the sewage treatment plant operation with the construction dependent limitations are to be given. Fundamentally the rebuilding phases are to be so planned that no degradation of effluent quality occurs.

Feed and properties of the wastewater and sludge

The feed of wastewater, infiltration water and stormwater as well as their timely distribution (also seasonal operation) are, as far as possible, to be determined by measurements. Properties are to be determined through wastewater examinations (assessment in accordance with ATV Standard ATV-A 131). If this is not possible the values laid down in ATV Standard ATV-A 131 apply for domestic wastewater.

The investigation programme is to be supplemented by surveys of the volumetric flow and properties of the industrial and commercial wastewater discharges. Loadings from internal processes (e.g. sludge treatment, filter flushing) influence the treatment procedure; these factors have a significant influence with later system dimensioning.

Delivered sludge is to be recorded by quantity and properties.

Competent specialist offices are to be tasked with the implementation of wastewater and sludge investigations.

1.1.4 Synopsis of Fundamentals

For practical purposes this is in tabular form and subdivided according to capacity status and, as a rule contains the results of Points 1.1.1, 1.1.2 and 1.1.3, in particular:

- numbers of inhabitants and population equivalents
- dry weather feeds (domestic wastewater, commercial and industrial wastewater, infiltration water
- pollutant loads
- specific daily amount of wastewater per inhabitant
- process water (inter alia internal circuits)
- feed characteristics (hourly average)
- stormwater inflow
- delivered sludge
- details on properties (e.g. pH value, acid capacity, settleable, dissolved and undissolved substances, chemical and biochemical oxygen depletion, nitrogen components, total phosphorus).

In individual cases it is to be examined whether further parameters have to be investigated.

With the planning criteria requiring particular attention are to be emphasised briefly and concisely. The fundamentals must be agreed with the construction sponsor and the other responsible offices.
1.2 Initial Planning

1.2.1 Determination of Basic Values

Assessment of the preliminary findings

Wastewater and sludge treatment processes as well as the position and height of the sewage treatment works must be determined taking into account the results from Point 1.1. "Preliminary Findings", in particular the required effluent values, joint stormwater treatment, operational reliability, local conditions of the selected location (subsoil, flooding conditions, groundwater etc.) and the effects on the environment.

The subsoil conditions can have an important effect on the arrangement of the individual structures and thus also on the overall design in the ground plan. The design of individual structures is also dependent on this.

Possible treatment processes

The selection of the wastewater treatment process is decided by the properties and quantity of the wastewater, by the required degree of treatment and by the local conditions. Biological treatment is the normal case.

The joint treatment of industrial and commercial wastewater, which is particularly heavily polluted or which contains harmful or toxic substances, as a rule, requires pre-treatment at source or the employment of special processes. With hazardous substances avoidance and treatment measures in accordance with the status of technology are to be applied. § 7 of the Water Resources Management Law (WHG) in the valid version and the thereto relevant promulgated administrative regulations are to be observed.

Reliable details on wastewater treatment possibilities and achievable treatment performances are, if required, to be obtained from trials plants: this concerns essentially industrial wastewater plants and municipal plants, with which the requirements go beyond the generally recognised rules of technology apply.

Sludge treatment

The selection of the process for sludge treatment is, in the same way, determined by the properties of the sludge and possibilities for the final accommodation of the residual matter. The required availability and process stability influence the choice of process.

Disposal of residual matter

The disposal or utilisation of the residual matter is to conform with the regional waste disposal concept.

Operating safety

With planning, precautions are to be taken for the case of operating faults.

Expansion

All planning must take into account expansion (connection value and increase in quality) in its concept. Nitrification, denitrification, filtration as well as biological and chemical processes for the elimination of phosphorus require, to a particular degree, special consideration.
1.2.2 Planning Variants

A technically, economically and ecologically secure planning conception cannot, as a rule, be achieved without solution variants. Schemes for processes ease comprehension.

An important aspect with wastewater engineering planning is the avoidance of noise and odour emissions. In depth investigations, depending on the type and separation of the development are necessary. Above all, in critical cases, noise and odour specialist reports are to be produced.

Estimates

The dimensions of the sewage treatment works structures (if required initial statics) are to be determined with the aid of the essential dimensioning parameters such as flow rates, surface feeding, sludge and volume loading etc. A hydraulic estimate generally determines the flow conditions.

General plan

The arrangement of the wastewater treatment facilities in the landscape is based on the general plan.

Layout plans

Various arrangement possibilities for the individual system components are to be presented in the layout plans:

- topography of the terrain
- particular local factors such as separation and type of development.
- position of the receiving water, roads and other traffic routes
- position of inter-regional supply lines
- necessary flow paths
- operational accessibility
- internal operational development possibilities.

Height layout

The height layout is as equally influenced by the height of the inflow sewer, the water levels of the receiving water, the head losses within the system and the terrain heights as by the site conditions and the level of the groundwater. The height arrangement of the wastewater treatment facility influences investment and also the operating costs (e.g. pump costs).

Plant and operating costs

Estimates on investments are to be carried out based on processed dimensioning data and planning documents. In addition, operating costs are to be estimated.

Estimate of economic efficiency

As a rule, the suitable solution comes from a result of the examination of alternatives. With this, the demands of water management functional safety, monitoring and maintenance have a particular importance. Higher investments can be justified by savings in operating costs. Attention is drawn to the "Guideline for the execution of cost comparison calculations" recently issued in 1990 by LAWA [Länderarbeitsgemeinschaft Wasser - (German) Federal State Study Group Water], which is based on social costs.
1.2.3 Proposal for Solution

The proposal for solution is the result of the examination of variants agreed by the construction sponsor and the specialist authorities. It is the most suitable with consideration of all relevant environmental engineering, process technical, economic and ecological factors and thus the basis for the approval draft and the implementation planning.

The assessment and the comparison should take place based on a catalogue of criteria using the following points: variations in loading, (e. g. due to foreign traffic) expansion possibilities, sewage sludge disposal, operating safety, investment costs (personnel requirements, energy requirements) environmental compatibility (noise protection, odour and pollutant emissions etc.

The proposal for solution consists of:

- explanatory report
- relevant wastewater engineering and hydraulic calculation
- general plan
- layout plans
- height plan
- general representation of structures (building sketches
- cost estimate.

1.3 Approval Draft (Design and Approval Planning)

The approval draft serves as basis for the specialist technical examination by the responsible offices of the Federal (German) States. First of all, or at least, in parallel, the application for permission under water law should be presented. The draft is based on the proposal for solution for the initial planning. A form of draft is to be sought, which eases a specialist technical examination by the responsible offices.

The interaction between the structure and the overall technical equipment is to be observed within the framework of draft planning (overall planning).

The necessary static verification based on building supervisory regulations are, as a rule not required for the examination under water management considerations and water law. It is therefore recommended that the static calculations are produced first after the approval of the draft. It could be different, if the approval under water law includes the building approval.

The following statements are to be seen as a guide only. It is necessary, in every case, to hold discussions with the responsible offices on the scope of the draft before beginning production of the draft. With this, it is also to be agreed to what extent the approval draft can be the basis of further approvals (Point 1.3.5).

The approval draft consists of:

1.3.1 Explanatory Report

General

Here, details are to be given on the subject of the measure, the initiation of the production of the draft, decisions of the community or city councils, instructions of the responsible offices, time span for realisation as well as commitments from contracts (under both private and public law). Attention is to be drawn to already existing drafts (systems for wastewater discharge and treatment) including initial planning (Point 1.2).
In summary, attention is to be drawn to the initial tasks carried out under Point 1.2.3 "Proposal for solution (inter alia examination of variants). The explanatory report describes - depending on requirements - the overall situation, the boundaries of the catchment area (sewerage areas, decision for individual or group sewage treatment plant, influent, connector and discharge sewers, stormwater tanks, pumping stations), the existing water management conditions, water quality, water flow and water levels etc.), the location of the wastewater treatment facility (general position, development of the system site) as well as the correct disposal of the residual materials produced.

Bases of the draft

"Synopsis of fundamentals" is to be carried in tabular form in accordance with Point 1.1.4: number of inhabitants, population equivalents, dry weather flow (domestic wastewater, commercial and industrial wastewater, infiltration water), pollution loads, process water (inter alia internal circulation) influent characteristics (hourly average), stormwater flow, delivered sludge, details on properties (e.g. pH value, acid capacity, settleable, dissolved and undissolved substances, chemical and biochemical oxygen demand, nitrogen components, total phosphorus) etc. The water management conception and the selected treatment process are to be thoroughly justified. With generally unknown treatment processes a functional description is, in any case, required.

Description of structures and facilities

The individual parts of the wastewater treatment facility are to be described according to type, size, dimensions and number, according to peculiarities of the structural form and construction work, according to their mechanical and electrical engineering as well as measurement and regulation equipment in their functional interrelationships (process flow diagram).

Emissions from the wastewater treatment facility with possible effects on third parties are to be presented and essential protective, measures are to be explained (specialists).

Measures with operating faults

The report must contain details on the handling of operating faults and emergency situations.

Operating personnel

Details on the necessary number and qualification of the personnel required for operation and maintenance are required.

Cost details

Results of cost determinations in accordance with Point 1.3.2 are to be given and explained in abbreviated form, if necessary in tabular form.
1.3.2 Calculations

Water engineering calculation

For every structure of the different plant components of a wastewater treatment facility, such as:

- stormwater treatment facility
- mixing and balancing tanks
- pump stations
- mechanical treatment facilities (influent group and primary treatment)
- biological treatment facility (incl. secondary and intermediate treatment)
- advanced wastewater treatment
- sludge treatment

the number, dimensions and the volume of tanks, containers, chambers etc. are to be verified. These structures are to be presented with the essential dimensions. In addition, specific detail verification for each system component are also to be kept, such as, for example, for a primary treatment tank: flow time, surface feeding, sludge yield, volume and storage time of sludge troughs etc. With this, the specialist literature, firms publications as well as the associated dimensioning formulas and computer programmes are to be pointed out. Calculation coefficients are to be detailed.

Hydraulic calculation

Hydraulic calculation is to be produced within the scope of the approval draft. This provides, for each monitoring cross-section, the energy level, the position of the water table and the flow rate. The calculation takes place separately for all relevant influences taking into account the process water, also for the cases of special equipment. In all cases, the hydraulic functioning of the system must be ensured; with this the flow rates which result, play an important role.

The results of the hydraulic calculation are represented in a longitudinal section of the wastewater treatment facility and the effluent sewer, and these for stormwater flow and such special cases of operation, with which higher water levels occur. The longitudinal section contains the bottom and upper edge of channels, tanks and pipes as well as the water table level presentation takes place, displaced in height.

System costs

Here, inter alia, the following positions are to be recorded: acquisition of land, development (costs for approach roads, connection of electricity and water, safeguarding of receiving waters, demolition and levelling tasks, if required rehabilitation of contaminated sites, route networks and similar), drainage, hydraulic engineering measures, individual structures including operational accommodation, mechanical, electrical, measuring and control engineering equipment, landscaping architecture, engineer fees, site investigation and other ancillary construction costs (approvals etc.).

The overall system costs are absolute and are to be given referred to the total number of inhabitants and population equivalents (PT) and, if required, to the daily wastewater flow quantities.

Annual costs

To these belong:

- costs for operation and maintenance (in each case separate according to personnel and material costs)
- costs for capital services (depending on the form of organisation of the system operator)
- depreciation
monitoring in accordance with (German) Federal State Water Law

- wastewater charges.

The total annual costs, as for the system costs, are to be given as absolute and specific (see above). The costs are to be reconciled both with the planning status as well as with the operating status.

The calculation of the overall annual energy consumption takes place in kWh/kg BOD₅ degradation and kWh/m³ wastewater.

### 1.3.3 Planning Documents

#### Catchment area plan

Scale 1 : 25,000 or 1 : 10,000

A plan with the following contents is to be produced for the catchment area:

- determined and planned water and medicinal spring protection areas, water catchment and bathing facilities as well as wastewater treatment facilities
- nature preserves and conservation areas
- receiving water (name, direction of flow, official river stationing in kilometres, river basin indicator) with the limits of flooding areas in the vicinity of the wastewater treatment facility
- discharge point(s) of the project with maximum and true value(s). other wastewater discharges
- wastewater treatment facility with catchment area
- existing and planned main collectors as well as pump stations with associated catchment areas
- stormwater overflows and stormwater tanks
- areas with combined and separate systems.

#### General plan of the area of the wastewater treatment facility

Scale 1 : 2,500, 1 : 1,000 or 1 : 500

In particular, the heights in metres above mean sea level (AMSL), the main dimensions of the wastewater treatment facility, the route network, possible expansion areas, discharge(s) to the receiving water as well as the land register plans and owner directory as at the latest status are to be presented.

#### Layout plan of the wastewater treatment facility

Scale 1 : 500 to 1 : 100

Contains the arrangement of the individual structures with regard to each other including dimensions, the route network as well as connecting pipelines for wastewater and sludge.

#### Landscape architecture attendant plan

Scale 1 : 1,000 to 1 : 100

For the examination in accordance with § 8, Para. 4 of the Federal German Nature Conservation Law (BNatSchG) as well as with the necessary measures for nature conservancy, for the care of the landscape and for environmental compatibility according to Federal State laws, a landscape architecture attendant plan/seeding plan is necessary. A specialist planner should be engaged for this.
Longitudinal section

The longitudinal section through the wastewater treatment facility and the effluent sewer up to the receiving water is to be produced in the height scale of 1 : 100 and the longitudinal scale as for the layout plan.

A displacement scale of 1 : 5 is preferred. The plan is to contain the water table levels determined in the hydraulic calculation. Additional longitudinal sections are possibly necessary for the sludge paths - in particular in the gravity flow area.

Structure plans

Scale 1 : 200 to 1 : 100

All important structures are to be represented in plan view and in the various sectional levels (longitudinal and cross-sections).

Important design heights are to be referred to MSL. Elevations are to be attached for surface buildings.

Special representations

As a rule, functional plans and flow diagrams are useful.

1.3.4 Submission of the Draft Design

The draft design of the wastewater treatment facility - with the legally binding signatures of the applicant, the installer and, if required, the owner of the measure - is to be presented, in the respectively necessary number of copies of the draft to the responsible office via the official route laid down by the respective Federal State.

1.3.5 Information on Additional Approvals

In close material connection with the facility approval for the construction and operation of the wastewater treatment facility, is the authorisation under Water Law (§ 7 of the Water Resources Management Law (WHG)), for the wastewater discharge associated with this. Such permission is also required for possible process water removal from a lake or river and for the lowering of the groundwater level or groundwater removal in connection with the construction. In addition, under certain circumstances, further authorisations under water law can be required, for example for the erection of structures in and on lakes and rivers or for measures within flooding or water protection areas.

So far as authorisation under water law for the wastewater treatment facility is not covered by the examination under building regulations - which will be the case only in exceptions - building authority has to be applied for additionally. For the storage of oil, liquid gas and the employment of water hazardous substances, for example with plants for chemical precipitation, additional approvals are necessary, possibly according to Federal State regulations. Authorisation from the river and waterways police (§ 31 Waterways Law (WaStrG)), the extension and access authority according to the Federal Trunk Road Law or the Federal State Road Laws, the exceptional approval in nature conservancy and landscape protection areas or the forest conversion approval according to the Federal State Forestry Laws must be applied for additionally in special cases.

With government financial aid the appropriate budgetary or other approval must be obtained.

Following the availability of the above named approvals, the prerequisites have to be acquired which allow the conclusion of authorising contracts as well as the conclusion of contracts with third parties (supply lines for electricity, water, gas etc.).
1.4 Implementation Planning

Implementation planning is the prerequisite for an orderly execution of the construction. It is developed, after completion of the approval process under water law - taking into account the therewith connected regulations and conditions, from the draft approval and is kept updated. All previous planning activities are combined within the framework of the implementation planning. The implementation plans are the basis for the raising of performance descriptions and specifications.

Planning details are to be developed from the continuous and joint contacts of all those involved in the planning and approval.

Within the framework of the wastewater and sludge areas there are, inter alia, questions to be clarified on the layout of mechanical and electrical engineering installations, process reliability (reserve plant, exchange, bypassing) as well as on measuring, control, regulation and information technology, incl. documentation also with regard to operating faults. For the processing of special equipment such as, for example, own power generation, heating and ventilation facilities etc., specialist planners are to be involved so far as the person responsible for planning does not have the appropriate specialist knowledge.

In the construction engineering implementation planning, there are the initial technical specifications which are, if required, to be incorporated, due to the reactive individual data on installation openings, savings, load details as well as statically influenced modifications of the structural dimensions, arising from tendering action for the construction, mechanical, electrical, measuring and regulation as well as the heating and ventilation engineering. In the field of emission protection there are both the remaining emissions as well as those, which occur temporarily during the implementation phase. Insofar as modifications compared to the approval planning occur, their influence on the hydraulics are to be observed.

Planning documents are to be produced to the scale 1 : 50 to 1 : 10 (details).

Implementation plans are to be countersigned by the sponsor or his representative.
2 Construction Planning

2.1 Construction Preparation/Overall Construction Control/Project Management

Co-ordination point for the execution of the construction project is the overall construction control agency. It covers an area of performance from the start of construction until acceptance by the authorities. Project control is the task of the construction sponsor. It can be delegated to the engineer.

Organisational planning

- Production of operation plans for construction and commissioning
- Limitation of the performance areas
- Production of time and cost plans.

Preparation of request for bids

- Determination of the contractual and technical conditions
- Determination of quantities - incl. necessary replacement and expense items
- Setting up of performance description.

The documents for the request for bids, as a rule, cover the general, specific and additional contractual conditions as well as the general technical regulations and the performance description. With the request for bids, the Directive of the Council of the European Community (EG) on the Co-ordination and Procedure for the Award of Public Building Contracts (Building Co-ordinating Directive - BCD), as well as possibly existing regulations for award of the respective customers, are to be taken into account.

As a rule, there is a public request for bids for the services. A limited request for bids is indicated, if the service by its speciality can be carried out efficiently and reliably only by a limited circle of firms with appropriate specialist knowledge, e.g. mechanical and electrical engineering services. If required, a public participation competition is to be undertaken with subsequent limited request for bids.

Useful for the award of contract is the application of the Federal or Federal State Award of Contract Handbook for the Implementation of Construction Tasks. Furthermore, it is recommended that the Common Model for Requests for Tender (in Germany the EVM) from the contract award books is employed.

Tendering procedures

- Procurement of tenders
- Mathematical and technical examination as well as evaluation of tenders and secondary tenders. The evaluation of secondary tenders also requires the examination of the technical, economic and legal feasibility and comparability within the framework of the draft and the request for bids
- Production of a price level
- Examination of the time and cost plans
- Processing of the contract proposal and supplementary contract conditions due to the contract and/or subcontract.
Back-up during construction implementation

- Monitoring of the fulfilment of the contract by the various contractors in collaboration with the local construction supervisory board with regard to the implementation of technical services dates costs
- follow-up of technical corrections of one area of performance in other areas of performance.

Structures as well as mechanical and electrical engineering facilities can influence each other mutually.

2.2 Local Construction Supervision

Local construction supervision (if required with the involvement of appropriate specialists) monitors the work of all contractors for implementation in accordance with the contract. It co-ordinates the employment of different contractors on the construction site and monitors the performance and time plans. Intermediate acceptance, as a rule, is carried out by the local construction supervision. Results are to be recorded in a protocol.

In addition, the local construction supervision, together with the contractors, examines the performance measures and checks their calculations.

Certain activities of the local construction supervision influence each other mutually and, for practical reasons, are carried out together.

In accordance with Federal State Building Regulations a responsible project manager is to be named for the whole construction period.

2.3 Test Runs and Examination of Technical Equipment

Type and scope of performance verifications (e.g. tightness testing, functional tests) are to be laid down in advance. Acceptance must be in accordance with the generally accepted rules of technology.

2.4 Commissioning

The commissioning of the sewage treatment plant takes place, for practical purposes, in close cooperation between the planner, the overall construction control, the local construction supervision, the equipment suppliers and the responsible water authorities.

The operation of modern wastewater treatment facilities is to be optimised in the work up phase. System personnel must be supported by additional specialists for the necessary measurement, control and regulation as well as wastewater and sludge examinations, including the documentation of the data.

Inventory plans and operational instructions are to be elaborated for the completed system. These inventory plans, in particular, contain all modifications compared with the approval draft and the implementation planning. The operational instructions should take into account various operating conditions, emergency situations and failure of individual system components. It should also contain clear formulas and technical handling instructions with extreme conditions.
2.5 Final Acceptance

Final acceptance, which, as a rule, - in particular in accordance with the Contract Procedures for Building Works (VOB) - is preceded by individual and intermediate acceptances, is carried out with, inter alia, the following participants:

- the customer
- water authorities and associated specialist offices
- building regulation authorities
- responsible professional trade association and/or statutory accident insurance (GUV)
- authorities named in the approval.

3 Additional Information on Important Individual Tasks

From experience, quality assurance must be applied continuously, in particular also in the areas listed below. Those participating in the construction project must, in every individual case, incorporate numerous additional aspects and details.

3.1 Statics, Design, Implementation of Construction

General

The implementation of the wastewater structures is carried out mainly in reinforced concrete. Therefore only this method of construction is gone into in detail.

The drawings to be produced within the scope of the implementation planning in the scale 1 : 50 are the basis for constructional drawings which are necessary for the implementation of construction (formwork and reinforcement plans, structural steel engineering plans etc.).

Static calculation

The compilation of the static calculation takes place in accordance with the valid rules for statics and DIN standard specifications (DIN/CEN) taking into particular account:

- loading conditions conditional on operation
- security against foundation water pressure (with structures in groundwater)
- sensitivity to settling
- temperature differences (between container fillings and external air and the ground with settling tanks, digesters etc.)
- water impermeability of wastewater structures
- reduction or avoidance of the formation of cracks.

Influences on structural statics from the area of mechanical, electrical, heating and ventilation engineering

The dynamic loading, area loads, individual loads, wind loads, assembly loading etc., which arise from the installations must be included in the static calculation. With this, wall and ceiling openings, recesses and apertures are also to be taken into account. The raising of floors (floor pavement or paving tiles) as a result of the laying of pipelines and cables on the concrete surface may also not be left out of consideration.
Design information

Wastewater structures are subjected to heavy loading from operation and the environment. In order that the concrete is able to resist these effects over a long period, the following design criteria are, in particular, to be observed.

The shaping and dimensioning of components are to be considered equally from functional, economic and production engineering aspects. Components are to be so sufficiently dimensioned, that delicately structured designs can, as far as possible, be avoided.

Structural joints are to be provided for the avoidance of the formation of cracks. They are to be carefully presented in the implementation plans (control sheets) and are to be included in the specifications as a separate entry. Construction joints, which occur with interruptions to concreting, are to be avoided.

Position and formation of construction joints are to be noted by sewage treatment plant suppliers. The constructive formation of joints and the selection of materials have a particular significance.

The composition of the concrete must take into account the peculiarities of the sewage treatment plant construction. With this, the following important criteria are to be noted:

- water impermeability
- resistance against chemical attack from wastewater, groundwater
- resistance to frost and de-icing salt
- resistance to wear against mechanical attack.

In special cases protective coatings are necessary with very heavy chemical attack.

Concrete covering of the reinforcement is to be carried out in accordance with DIN 1045 (July 1988 Edition). In sewage treatment plant construction the standard dimensions of Table 10, line 3 (4.0 cm) and line 4 (5.0 cm) are applied.

The Advisory Leaflet "Concrete Covering" (October 1982) issued by the German Concrete Association (DBV), is to be observed.

An improvement of the properties of concrete can be achieved by final compaction (vibration) of the still unhardened concrete. The tendency towards crack formation is also reduced by this.

Further details on concrete processing with the crowning of walls, on concrete quality with trackways as well as on expansion joints see DIN 19569, Part 1.

The concrete is to be protected against premature drying out, extreme temperatures, chemical attacks, shocks and vibrations until it is sufficiently hardened. With wastewater structures it is not so much the core compression strength of the concrete but much more the water impermeability and strength of the layers near the surface (concrete covering), which are important. Of decisive significance for the durability of the concrete is the duration of final treatment. It is to be determined dependent on the ambient temperature, the cement and the composition of the concrete [for this see DIN 1045 (July 1988), Para. 10.3 and the "Standard for the final treatment of concrete" (February 1984 Edition) of the Standard Instructions for Registrars and Their Supervisory Authorities (DafStB)].

Shuttering, which is installed on sides which come into contact with wastewater should, for technical operating reasons, have a smooth surface. Smooth, plastic coated shuttering or steel shuttering can, for various reasons, lead to impairment of the stability and resistance to frost of the concrete. Water absorbent and other water transporting shuttering systems are therefore more suitable than repellent shuttering.
Shuttering anchors or spacers (e.g. steel or fibre cement) are to have a good bonding with the concrete and extend the percolation route of the water. The type of shuttering anchor and spacer is to be laid down in the performance description.

Implementation of construction and assembly

A detailed construction timeplan, which must be kept continuously updated, is required for the implementation of the construction measures. Attention is to be paid, that the assembly of mechanical and electrical engineering equipment can often only take place, if certain prerequisites such as, for example, enclosed spaces for electrical plant, heating capability for rooms, lifting equipment etc. are met. With smaller and more medium sized projects, with a simple number of activities, in general a bar chart, which makes the critical path clear, is sufficient. This should, if required, be supplemented by the flow of financial means or other events immediately corresponding with the progress of construction. For large construction projects with complicated activities, the application of network techniques is recommended.

3.2 Mechanical Engineering

General

With regard to process control and design interdependencies between machine and construction element, there should already be, at an early stage in the process of draft planning, agreement between the mechanical and electrical engineering side on one hand and the construction engineering side on the other. The correct selection of the most suitable machines for the respective employment case has particular significance. From this results the requirement for space and surface area, location (accessibility for operation and maintenance), the loads, important apertures and foundations, possible measures against noise, shocks, heat etc.

Principles for the meshing of construction, mechanical and wastewater engineering, which are in particular to be observed during planning, construction and operation, are dealt with in DIN 19569.

Arrangement of mechanical installations

The arrangement of technical facilities is to take place, taking into consideration the rules of technology (Din Standard Specifications, regulations of the VDE (German Association of Engineers) and accident prevention of the responsible professional trade organisation etc.). With this, attention is to be paid, in particular to corrosion protected design, ease of assembly, inspection, servicing and maintenance as well as technically and economically optimised layout.

With the arrangement of mechanical engineering plant one should not work on the principle of the final layout, but rather the maximum impact on the wastewater treatment facility during the economic life of the mechanical facilities.

With consideration of plant personnel, the hygienic aspects are to be taken into account with the selection of the overall mechanical engineering equipment.

Pumps are to be designed taking in to account the requirements of the medium to be transported (e.g. pollutants, dry substance contents with sludge) as well as the process technical and operational conditions (e.g. annual running time). Reserve plant must be held ready in sufficient quantities. The layout of pipelines is to be so arranged that there are diversion possibilities with operational failures. The same applies for blowers.

Requirements on the functioning and functional process of machines, outputs (such as work output and output capacity) functional diagrams and control engineering are to be laid down precisely in the performance specifications.
Firms’ details on the dimensions of machines and their loads are required for the production of design drawings and the static calculation of structures. Scraper bridges and similar structures are also to be verified statically.

### 3.3 Energy Concept and Electrical Engineering

#### General

The particular requirements of treatment processes on reliability and availability, together with the requirement for an economic solution, also form the basis for the design of the energy supply and distribution system. These aspects can also influence the concept for a system and must be included in the planning at an early stage. The appropriate regulations of the energy supply concerns, the DIN Standard Specifications as well as VDE and accident protection regulations are to be taken into account.

For larger systems the development of an energy concept is recommended. The generation of mechanical or electrical energy from digester gas has gained in significance in the discussion on the thrifty usage of energy resources. Here, the economic efficiency of the digester gas and heat utilisation is to be investigated case by case. The larger the wastewater treatment facility is, the more economic is gas powered generation. In any case a timely agreement with the power supply concern is required.

#### Electricity connection

First the power requirement is to be determined from the sum of the nominal capacities of the individual electricity consumers, the simultaneity factor and the safety considerations. The voltage level is to be selected according to the power requirement and possibilities offered by the power supply concern. Here, high currents at make for large consumers must be taken into account. The layout and arrangement of the switching plant results from this.

#### Reliability of supply

Supply from the public network is to be determined taking into account reliability of supply of the respective network and the type of power supply (supply from open/closed ring networks or radial networks, unbalanced/ balanced feed, underground cable or overhead lines) based on the reliability requirement of the sewage treatment plant.

As a rule, a balanced power supply from an open ring network - if possible with selective cutoff - should be demanded. With possible own power supply or an appropriate emergency power supply, lower requirements can be placed on outside power supply.

Even with own power supply a connection to the public network is necessary - at least by one cable.

The construction site should, if possible, already be supplied by the final cable. Details on the power requirements are to be given in the offer. The acceptance of costs for the usage of power during construction is to be regulated under "Special contract conditions".

#### Electrical engineering facilities

To the electrical engineering facilities of medium and large sewage treatment plants belong, in general, the medium high voltage switching system, transformers, the low voltage main switching system, sub-distributors, local control boxes etc.

There is a close relationship to the measuring and regulation requirements, through which details on the type and scope of control and regulation on site or in a central control and the flow of data information is determined.
The build-up of the switching system is to be planned according to the requirements on the operational safety of the wastewater treatment facility. The various solution possibilities are to be compared with each other based on efficiency and costs, in particular, however, also with regard to the constructional expenses (space requirements for transformer cells, switching systems and central control).

The practical selection of individual switching equipment - such as isolating switches and circuit breakers, protective motor switches as well as the appropriate safety facilities - has important influences on reliability and costs.

Moreover, questions of overvoltage protection, earthing, reactive power compensation and current reactions (e.g. through frequency converters) are to be clarified.

Cabling

To save construction costs the principle of bundling for the laying of cables and pipelines is to be observed (man-accessible and non-man-accessible drains and sewers, empty pipe systems). If required, necessary planning for this is to be set up well in time.

3.4 Measuring, Control and Regulation Technology

With the aid of measuring, control and regulation technology (MCR technology), important processes are automated and information obtained, which enable a reliable and economic operation. Using process data processing (PDP) this information can be further processed.

Equally, fault reporting facilities are also to be installed. So far as external operating points also influence operating procedures, these are also to be included in the information system.

With systems with PDP facilities, the type and scope of the automation system to be installed must be available as early and as completely as possible.

Bases for the selection of the MCR technology are the process description (process schema, if required, regulation and information schema), the description of the system conception, the requirements on observation and operation of the system in the form of measuring point and functional plans as well as reliability and availability requirements.

The result of this planning is described in the performance specification. Here, the terms of reference are to be refined with regard to the scope of measuring points (e.g. recording of limiting values), the controls, regulators, transfer of measured values, signal transmission, signal processing, process presentation, servicing concept, recording, data security and documentation.

Firm descriptions of all functions, dependencies, data, measuring points, power sets, controls, regulators, signal transmission and programmes are firmly laid down and the dates, documentation, constraints for assembly and commissioning are explained (performance specification for the request for and award of contract), within the scope of the detailing planning (construction planning).

With complicated systems thought is to be given as to whether maintenance contracts should be offered, with the request for tenders, for the hardware and software which are to be employed.

The VDE regulations and ATV Rules and Standards are to be observed.
3.5 Heating and Ventilation engineering

In the first instance digesters, social buildings as well as workshop and garage buildings are candidates for heating.

Enclosed screening and sludge dewatering plants normally receive only heating protection against frost. Facilities for the employment of a reserve fuel (oil storage tank, natural gas connection or liquid gas tank) are to be held ready. With the layout of the heating system operational buildings are also to be taken into account.

A gas tank and a gas flare are required to balance the varying times of production and utilisation of digester gas. On wastewater treatment facilities low pressure storage is preferred for employment. German Association for Gas and Water (DVGW) Standards are to be observed for the installation of gas tanks. With gas flare facilities for the disposal of surplus digester gas the Accident Prevention Regulations for the separation between gas flare facilities and buildings are to be observed.

If there is no digester on small wastewater treatment facilities, the exhaust heat of the compressed air production facilities (blowers, pressure air lines) can be used with a small temperature level for the heating of social, workshop and garage buildings.

Particular value is to be placed on a correct aeration and ventilation of the heating, gas metering, gas engine and blower rooms. Exhaust heat from mechanical and electrical equipment must be removed without harm. With electrical operation rooms the necessity of air conditioning is to be examined.

3.6 Immission Protection

Noise protection

Care is to be taken with the planning of wastewater treatment facilities that noises emanating from the facility do not lead to an exceeding of the immission guidance values laid down, depending on usage, in the (German) Technical Directive Noise. For the preservation of evidence, the existing noise level should be determined before the realisation of the measure.

Odour

In wastewater treatment facilities there are areas which tend towards increased odour emission, in particular with unusual operating conditions. In the individual case it is to be examined whether it is practical to design system components, planned as open buildings, to be capable of being covered, in order to be able to carry out possible potential improvements. In such cases the necessity of treating extracted air and protection against explosion are to be taken into account.
1.1 Initial Findings

1.1.1 (German) Federal and Federal State Regulations
- Water Resources Management Law (WHG)
- Water Charges Law (AbwAG)
- Waste Law (AbfG)
- Federal Immission Protection Law (BimschG)
- Law on the Environmental Compatibility Examination (UVPG)
- Federal Conservation Law (BnatSchG)
- Federal Waterways Law (WaStrG)

1.1.2 Other regulations and specifications
- Regional and area development plans of the (German Federal States)
- Construction management planning
- Municipal regulations
- Assets and development
- Discharge possibilities

1.1.3 Preliminary studies and investigations
- Sewer network
- Individual/group sewage treatment plants
- Questions of location
- Disposal of residual matter
- Expansion measures
- Feed and properties of the wastewater and sludge

1.1.4 Summary of fundamentals

1.2 Initial Planning

1.2.1 Determination of Basic Values
- Assessment of the preliminary findings
- Possible treatment processes
- Sludge treatment
- Disposal of residual matter
- Operating safety
- Expansion

1.2.2 Planning Variants
- Estimation
- General plan
- Layout plans
- Height layout
- Plant and operating costs
- Estimate of economic efficiency

1.2.3 Proposal for Solution
- Explanatory report
- Relevant wastewater engineering and hydraulic calculation
- General representation of structures (building sketches)
- Cost estimate

1.3 Approval draft

1.3.1 Explanatory Report
- General
- Fundamentals of the draft
- Description of structures and facilities
- Description of operating faults
- Operating personnel
- Cost details

1.3.2 Calculations
- Water engineering calculation
- System costs
- Annual costs

1.3.3 Planning Documents
- Catchment area plan
- General plan of the area of the wastewater treatment facility
- Layout plan of the wastewater treatment facility
- Landscape architecture attendant plan
- Structure plans

1.3.4 Submission of the Draft Design

1.3.5 Information on Additional Approvals

Costs and financing
- Production costs
- Cost allocation base
- Municipal share
- Industrial share
- Funding
- Loan servicing
- Operating costs
- Wastewater charges

Permission to discharge wastewater approval in accordance with Federal State and State ordinances

Draft Approval/Construction Approval

Preliminary discussions
- Sponsor - planner
- Sponsor - approval authorities
- Municipalities
- Commerce
- Industry

Initial negotiations and/or agreements with
- Subsoil survey if required
- Investigations into acquisition of land

Inventigations of the wastewater
- Quantity
- Characteristics

Trials plant (in special cases)

Collaboration with approval authorities and other specialist authorities

Documents on the environmental impact assessment (EIA)
Approval Draft /Construction Approval

1.4 Implementation planning
- Comprehensive layout plan
- Implementation and detail plans of all structures
- Implementation planning for all equipment
- Height plans of sewers, drains, roads
- Incorporation of individual data in reaction to the results of requests for tender

2.1 Construction Preparation/Construction Supervision
- Technical co-ordination
- Planning and monitoring of construction progress
- Agreement with authorities and service suppliers
- Cost plan
- Timeplan
- Invitations to tender
- Proposals for award

2.2 Local construction monitoring
- Monitoring of construction implementation for design fidelity and contract accuracy
- Performance and time control
- Observance of technical instructions and statutory rules
- Evaluation and auditing of invoices for correctness
- Acceptance and pressure testing
- Updating of cost and time plans
- Co-ordination of the employment of various firms on the construction site

2.3 Test Runs and Examination of the Mechanical and Electrical Engineering Installations with Performance Record

2.4 Acceptance

2.5 Final Acceptance

Operational Instruction

Functional instruction

Run-up of the wastewater treatment facility

Funding
- Appropriation of funds
- Authorisation contracts/contracts with third parties

Performance descriptions with specifications
- Interior works
- Building shell
- Mechanical engineering
- Electrical engineering
- MCR technology
- Subsoil investigations
- Assessments
- Initial statics
- Statics
- Shuttering and reinforcement plans
- Test statics
- Survey
- Mechanical engineering
- Electrical engineering
- MCR technology

Determining of supply lines in the area of the wastewater treatment facility and agreement with the suppliers with regard to connections

Updating of implementing drawings
- Examination of installation and recessing drawings from equipment firms
- Continuous supplementing and expansion of implementation drawings
- Continuous examination of the shuttering plan

Acceptance of Work
- i.a.w. VOB/VOL and Construction Approval

Inventory drawings

Landscape planner

Responsible project manager i.a.w. Federal State construction ordinance

Award of contract

Architect

Subsoil investigations Assessments

Initial statics Statics

Shuttering and reinforcement plans

Test statics

Survey

Mechanical engineering

Electrical engineering

MCR technology