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# MILITARY HANDBOOK

## PLANNING AND COMMISSIONING WASTEWATER TREATMENT PLANTS

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ABSTRACT

This handbook provides guidance on commissioning wastewater treatment facilities to Air Force environmental, engineering, and operations personnel. The guide covers the essential activities involved in commissioning treatment plants: planning, programming, design, construction, and inspection and performance commissioning. This instruction complements the related activities of wastewater treatment plant design, construction, and operation, while emphasizing the procedures unique to facilities commissioning. Thus, the handbook presents guidance information on required engineering studies, cost estimation, scheduling, recordkeeping, startup testing, performance certification, training, and operations manual preparation.

# FOREWORD

This handbook guides the reader in commissioning wastewater treatment facilities. It is intended to be consistent with U.S. Army Corps of Engineers Regulation ER 1110-345-723, Engineering and Design Systems Commissioning Procedures.

THIS HANDBOOK SHALL NOT BE USED AS A REFERENCE DOCUMENT FOR PROCUREMENT OF FACILITIES CONSTRUCTION. IT IS TO BE USED IN THE PURCHASE OF FACILITIES ENGINEERING STUDIES AND DESIGN (FINAL PLANS, SPECIFICATIONS, AND COST ESTIMATES). DO NOT REFERENCE IT IN MILITARY OR FEDERAL SPECIFICATIONS OR OTHER PROCUREMENT DOCUMENTS.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: HQ AFCESA/CES, 139 Barnes Dr., Tyndall AFB, FL 32403-5319, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

COMMISSIONING CRITERIA MANUALS

| Criteria Manual | Title |
|---|---|
| AFM 88-11 | Domestic Wastewater Treatment (Vol. 3) |
| ER 1110-345-723 | Engineering and Design Systems Commissioning Procedures |
| MIL-HDBK-XXX | Wastewater Design Handbook |
| MIL-HDBK-XXX | Wastewater Operations & Maintenance (O&M) Handbook |
| MIL-HDBK-1005/8 | Domestic Wastewater Control |

# PLANNING AND COMMISSIONING WASTEWATER TREATMENT PLANTS

## CONTENTS

# Section 1: INTRODUCTION

1.1 Scope. This handbook serves as a planning guide for commissioning wastewater treatment plants (WWTPs). Adequate planning prevents unnecessary construction delays and costly modifications and ensures efficient plant operation. Guidance is presented in general terms; you must integrate site-specific requirements. Appendix A provides a checklist for scheduling tasks and assigning responsibility. This checklist may be copied or changed to suit your requirements.

1.2 Purpose. The purpose of precommissioning is to prepare for a successful commissioning. Adequate programming, design, and construction will accomplish this goal. This handbook assumes the traditional method of project delivery; criteria and requirements are presented accordingly. In-house design or other approved delivery methods such as Fast Track or Design-Build are not precluded. Most, if not all, of the requirements and guidance presented in this handbook are appropriate for these other methods.

1.3 Commissioning Procedures. A WWTP must be operated in accordance with the project design requirements. Sections 6 and 7 describe requirements for commissioning a WWTP, including verification of system operation to the component level.

# Section 2: FACILITIES PLANNING

2.1 Objectives. Planning is the first step in precommissioning a WWTP. It involves identifying requirements, defining deficiencies, identifying possible corrective actions, and reviewing environmental regulations. Planning will determine the need for the proposed facilities. Life-cycle cost (LCC) analysis will ensure that alternatives are based on total cost of ownership. Facilities planning will demonstrate that the selected alternative is the most economical means of meeting the requirements. Design-related performance-limiting factors will identify potential problems. Electrical, hydraulic, and mechanical design criteria will provide for component and system reliability. Planning is primarily the responsibility of the base environmental flight. Base engineering and operations flights should assist as necessary in initiating studies and requesting project funding and approval.

2.2 Requirements. The requirement for a new or upgraded WWTP may result from changing conditions at the facility or from compliance deficiencies identified during facility evaluations.

2.2.1 Facility Changes. Existing facilities may be inadequate because of a recent or upcoming change in mission and may require replacement due to physical condition or ineffective technology.

2.2.2 Compliance Requirements. The WWTP may be out of compliance with environmental regulatory requirements and require a new or upgraded facility to correct the deficiency. The compliance requirement can be identified through an Environmental Compliance Assessment and Management Program (ECAMP) audit or an Operations, Maintenance, and Training Assistance Program (OMTAP) study. New or pending regulatory requirements may also indicate a compliance deficiency.

## 2.3 Problem Definition and Probable Corrective Actions

2.3.1 OMTAP Study. Conduct an OMTAP study, if one has not already been performed. This study assures that problems are significant and eliminates the possibility that they are operational in nature, requiring only minor modifications.

2.3.2 Regulations Review. Next, review all applicable environmental regulations to ensure the project will correct all deficiencies. This review also ensures that appropriate discharge standards will be met. If pending regulatory requirements are well defined and unlikely to change, they also should be considered to ensure long-term compliance.

2.3.3 Additional Studies. Further studies may be needed to better define the scope and nature of corrective action. Studies help define existing conditions and should be conducted before the evaluation of alternatives, when possible (par. 3.5).

Many publications helpful in identifying needed studies are available from the Environmental Protection Agency (EPA), professional societies, and other sources. One example is PB-215-494, Federal Guidelines: Design, Operation and Maintenance of Wastewater Treatment Facilities, published by the Federal Water Quality Administration (FWQA). Although dated and directed toward municipalities, this publication still contains useful guidance. Part A of PB-215-494 deals with concepts and studies that should be used in planning and project definition (PD); Part A is included in this handbook as Appendix B.

Several types of studies may be required before a project can be properly defined:

a) Toxicity reduction evaluations.

b) Industrial waste minimization studies (pollution prevention).

c) Wastewater pretreatment requirements. (An existing base wastewater regulation should address pretreatment requirements and be updated at the completion of the project.)

d) Wastewater characterization and toxicity identification evaluations. (Armstrong Laboratory at Brooks AFB, Texas, can assist with this effort.)

e) Infiltration/inflow (I/I) studies (flow reduction).

f) WWTP siting.

g) Effluent reuse and disposal alternatives.

2.4 Environmental Deficiencies Reporting. Identify facility deficiencies early in the planning effort and report these deficiencies on environmental reports such as the Federal Agency Pollution Abatement and Prevention Project Plan (commonly known as the A-106 report) as required by AFI 32-7002, Environmental Information Management System. The A-106 is a planning tool used to identify, track, and report pollution abatement projects that will enable the Air Force to meet environmental requirements.

2.5 Funding. Studies are funded with Operation and Maintenance (O&M) or Environmental Compliance money. Major upgrades are funded with military construction (MILCON) money. Environmental Compliance money may be used for O&M or MILCON as long as requirements and supporting documentation are provided when the funds are requested. Projects must be approved by the base Facilities Utilization Board, then sent to the major command (MAJCOM) for review.

## Section 3: PROGRAMMING

3.1 Prior Approval and Validation. The requiring MAJCOM must approve and recommend a WWTP MILCON project to the Air Staff. Before projects are programmed in the Air Force budget, Headquarters Air Force Civil Engineer Support Agency, Systems Engineering Directorate (AFCESA/CES) may review them for adherence to technical design standards and criteria. The Air Staff will not approve MILCON WWTP projects without an adequate evaluation of conditions and alternatives. Headquarters Air Force Directorate of Environmental Quality (HQ USAF/CEV) must also validate environmentally funded projects by confirming compliance requirements. The Air Force Directorate of Military Construction (AF/CEC) then validates project requirements and the Air Force Resource Allocation Process approves the requirements. AF/CEC notifies the requiring MAJCOM of an approved project by issuing a Planning Instruction (PI). The PI is the Command's formal notification to begin design on the project. At their discretion, the Command authorizes the extent of design activities with the Design Manager (DM).

3.2 Requirements and Management Plan (RAMP)

3.2.1 Advanced Planning with RAMP. Finalization of a RAMP signals the start of the advanced planning phase of a project. ETL 95-2, Preparation of Requirements and Management Plan (RAMP) Packages for Military Construction (MILCON) Program Projects, offers guidance on preparation of the RAMP package. The RAMP provides project planning information to the Design Agent (DA), the DM, and the designer. It contains project description, data, criteria, requirements, and cost information to support programming and design of the MILCON WWTP project. The MAJCOM is responsible for completing the RAMP, but an Architect-Engineer (A-E) may assist with the preparation.

3.2.2 RAMP Project Management. The DM accomplishes the project management plan portion of the RAMP. The MAJCOM or Field Design Instruction (DI) should be issued to the DM no later than 30 days prior to completion of the RAMP to allow the DM to authorize the DA's participation in preparing the project management plan. This 30-day lead also allows initiation of all administrative actions before starting the design.

3.2.3 RAMP Review and Distribution. The RAMP must be reviewed by the DM within 60 days of PI issuance. The contents must agree with the PI, DI, and DD Form 1391, Military Construction Project Data. The DM then must send the RAMP to the DA for distribution to the designer. The designer must see the RAMP before the predefinition conference (PC) in order to know and understand the AF requirements. The MILCON design process and timeline are depicted in flowcharts provided in Appendices C and D. These charts are illustrations from the AF Project Manager's Guide for Design and Construction, available from Air Force Center for Environmental Excellence (AFCEE/CM), Brooks AFB, Texas. The RAMP should be used in negotiating the design contract and completing the PD phase of the project.

3.3 Engineering Studies. Complete wastewater characterization and other studies (par. 2.3.3) required to fill identified deficiencies. Some studies will take considerable time and should be initiated early in the planning process. Copies of the studies must be submitted to both the base environmental and engineering design organizations for review and comment.

3.4 Future Air Force Requirements. Review the Base Comprehensive Plan (BCP) to ensure the WWTP project supports other planned facility expansions. Other on-base organizations should also have the opportunity to provide input, particularly where related to unit mission changes not detailed in the BCP. Future requirements that can affect the WWTP project include, but are not limited to, the following:

a) Base population increase or decrease

b) Mission change

c) Pending change in regulatory requirements

d) Planned change in industrial discharge from process modification, material substitution, or functional changes

3.5 Evaluation of Alternatives. An evaluation of project alternatives should include nonconventional projects and innovative solutions to the problem. All solutions must consider pollution prevention, recycling, wastewater reuse, and long-term environmental compliance requirements. Operability and maintainability as well as LCCs and environmental compliance must be considered. Each alternative must be reviewed by base engineering personnel, graded on each criterion, then ranked. After ranking, the best alternative shall be presented to base organizations, higher headquarters, local, state, and Federal agencies for review and comment. A-E services are typically used for this effort. The A-E may also be used for the review of engineering studies (par. 2.3.3), the development of facility requirements (par. 3.8), and the preparation of the RAMP (par. 3.2).

3.5.1 Publicly Owned Treatment Works (POTW) Connection. Develop and consider costs for connecting to a POTW when proposing new construction or rehabilitating or expanding an existing facility. HQ AFCESA/CES can assist with connection cost analysis. POTW connection and service costs must be compared to the design, construction/rehabilitation, and operational costs of the proposed on-site alternative.

Connecting to a POTW shall be the preferred alternative when the life-cycle costs are favorable: 125 percent or less than the cost of the proposed on-site system. This bias for connecting to the POTW is justified by the high cost of meeting future environmental requirements, added restrictions for on-site systems, increasingly complex plants, and the need for skilled and certified operators.

3.5.2 Economic Analysis. Conduct economic analyses as part of the design process to ensure that selection of design alternatives is not based solely on construction cost but includes least life-cycle or total cost of ownership. The depth and degree of formality of these analyses shall be determined on a case-by-case basis to ensure that analysis costs are proportional to project magnitude. Results of previous analysis involving the alternatives under consideration may be used in lieu of a new analysis, if the analysis assumed similar design conditions, used appropriate criteria and methods, and used adequately updated and detailed documentation. All economic analyses and/or other justification for the selection of a design alternative, regardless of the method used, shall be clearly documented in the appropriate section of the project design analysis. In addition, a separate stand-alone document or appendix describing the details of the study (method, criteria, assumptions and data used; calculations; results; and conclusions) shall also be provided.

All analyses shall consider the total LCC for design alternatives, where the LCC includes all costs associated with an alternative over its expected life including, but not limited to, construction/procurement, energy, maintenance, operation, repair, alteration, and disposal costs. The present value discounting approach, as described in AFMAN 65-506, Economic Analysis, shall be used unless otherwise specified by other AF instructions, by public law, or by AF Engineer Technical Letters (ETLs). The analysis period shall be the date of the study through the economic life of the alternative or 25 years from the Beneficial Occupancy Date, whichever is less. Base cash flow on actual calendar dates on which events and costs/savings are projected or scheduled to occur. Base estimates for all costs/savings on actual prices in effect on the date of study (constant date-of-study dollars).

3.6 Environmental Assessment (EA)/Environmental Impact Statement (EIS) Initiation. The initiation process for the EA and EIS is the Environmental Impact Analysis Process (EIAP). The EIAP must be completed to ensure compliance with the National Environmental Policy Act. This process is detailed in AFI 32-7061, Environmental Impact Analysis Process. Preparation of an EA typically requires 6 to 9 months. When a Categorical Exclusion or a Finding of No Significant Impact is not appropriate, then a full EIS must be prepared. The preparation of an EIS typically takes 12 to 18 months. Allow time to complete the EIAP before final project approval and funding.

3.7 Support Documentation. The primary programming document is DD Form 1391. This document is used to request and justify the WWTP project, as required by AFI 32-1032, Planning and Programming Real Property Maintenance Projects Using Appropriated Funds. DD Form 1391 details the project scope, cost, and any unusual features.

3.7.1 Required Cost Line Items. Include the following separate line items, described in later paragraphs, on DD Form 1391 as part of Item 9, Cost Estimate:

a) Systems O&M and component O&M manuals (estimated at $50,000 to $150,000).

b) Contract startup, training, and performance operating period (estimated at $150,000 to $250,000).

c) Lab test equipment and other items funded outside MILCON. Separate funding for these items must be requested but the items may be shown here.

3.7.2 Additional Cost Information. Complete the following items in Block 11 of DD Form 1391:

a) Summarize the alternative analysis described in par. 3.5 (may be attached). The summary must address innovative solutions and the alternative of connecting to a POTW. Guidelines and instructions on economic analysis must also be followed.

b) Designate the Environmental Compliance Level. The three levels follow:

(1) Level I: currently out of compliance.

(2) Level II: known future compliance requirements.

(3) Level III: compliance enhancement.

c) Address Level I and II designations. A Level I designation must be supported with noncompliance documentation from regulators or an official AF assessment. Level II designation must be supported with the date of future noncompliance and the specific regulation, standard, or other documentation.

3.7.3 Environmental Compliance Certificate. An Environmental Certificate of Compliance must be completed and attached to the DD Form 1391 package. This certificate addresses siting and environmental issues of the project and is completed by the base environmental planning section.

3.7.4 Cost Estimate Models. Computer software is available to help with cost estimation. Initial cost can be estimated using the Environmental Compliance POM Handbook, available from AFCESA/CES, or other cost models. Detailed cost models such as CAPDET PC can also be used during the PD phase so that the parametric cost estimates reflect the more detailed project requirements. Information on the CAPDET PC program can be found in Appendix E.

3.8 Facility Requirements. Decide as early as possible what design features will be included in the project, particularly Government-furnished equipment (GFE) or supplies. Because of the difficulties in managing GFE, their use is not recommended.

3.8.1 Future Requirements. Proper WWTP sizing should incorporate applicable future requirements identified in par. 3.4. The cost of increased plant size to accommodate high I/I rates must be balanced against the cost of correcting the I/I problem. A good guide is the EPA publication Infiltration/ Inflow - I/I Analysis and Project Certification (see Appendix F).

3.8.2 Facility Input and Printed Design Guidance. Plant operators and AF engineering staff must provide input on the facility requirements. Information from such publications as AFM 88-11, Vol. 3, Domestic Wastewater Treatment, should be incorporated. Another important publication is Design of Municipal Wastewater Treatment Plants, Vols. I & II, published jointly by the Water Environment Federation (WEF) as Manual of Practice No. 8 and the American Society of Civil Engineers (ASCE) as the Manual and Report on Engineering Practice, No. 76. Operation of Wastewater Treatment Plants: A Field Study Training Program, prepared by California State University, Sacramento, for the EPA (1990), addresses the concerns of WWTP operators. These sources may be used by civil engineering programming personnel in determining facility requirements for the WWTP project. Facility requirements necessary for design definition include, but are not limited to, the following:

a) Size and numbers of equipment items (to include piping)

b) Office and classroom area and operating space

c) Security features (fences and alarms)

d) Safety features (sprinkler systems, eye washes, and chlorine alarms)

e) Parking and traffic requirements

f) Laboratory facilities

g) Laboratory equipment

h) Supply storage area and supplier/operator access

i) Degree of automation

3.9 Regulatory Agency Participation. Lines of communication and points of contact must be established. The AF and DA must provide information to local, state, and Federal regulatory agencies. Regulatory agencies must be involved in the project review process to ensure compliance with regulations throughout the design and construction phases. Accurate and complete records of correspondence must be kept to substantiate discharge limits and other criteria agreed to by the regulators. Firm discharge limits are needed because the limits dictate treatment options. Attempt to design to standards that will remain unchanged for as long as possible.

# Section 4: DESIGN

4.1 Design Initiation. The Field DI will be issued to the DM by the requiring MAJCOM. The DI may be issued at any time after the MAJCOM receives a PI from AF/CEC. The DI is the authority to start design actions. These actions include design engineer selection, award, site investigation, and design.

4.2 Design Engineer Selection and Responsibilities. The first phase of the design process is the selection of a design engineer. The engineer designs the WWTP and develops performance criteria, prepares manuals and training plans, develops construction cost estimates, and conducts project oversight. Designing a WWTP is complex and manpower-intensive. Normally an A-E is contracted for the project; however, in-house design is feasible where experienced designers are available. As an initial task, the A-E should review and validate wastewater characterization and design-basis loadings. The same A-E is often used for many tasks, including PD, design, contract document development, construction oversight, preparation of System Operating Manuals, startup, performance operating period, operator training, and project consultation. Construction oversight may be limited to the specialized review of treatment equipment and design problems. This handbook assumes that the same A-E will complete all tasks. However, time, funding, and other constraints often dictate different arrangements.

4.3 Project Monitoring. The A-E shall use the best engineering practice. This means that documents shall be clear, concise, and unambiguous. Overly complex facilities and operations must be avoided. Simplicity is especially important regarding instruments and controls. In some cases, limited automation and monitoring may provide the best results. Monitoring should be compatible with base control systems, if practical. Treatment components and systems should provide operational flexibility and allow for future expansion. The facility must be capable of modification or expansion without excessive cost. To reduce costs of adding structures, modular concepts can be used. Perhaps more important is the capability to meet changes in discharge requirements. New requirements could include discharge limits on additional parameters and lower discharge limits on existing parameters. Modifications could also be required to meet new regulations, such as air quality or land disposal restrictions.

4.4 References. The following reference documents are helpful in WWTP project design:

a) PB-215-494 (see Appendix B).

b) EPA-430-99-74-001, Technical Bulletin: Design Criteria for Mechanical, Electrical, and Fluid Systems and Component Reliability (included as Appendix G).

c) EPA-625/6-84-008, Handbook for Improving POTW Performance. In particular, see Appendix H, Design-Related Performance-Limiting Factors (included as Appendix H in this guidance).

d) AFM 88-11, Vol. 3.

e) AFI 32-7061.

f) AFMAN 65-506.

g) Design of Municipal Wastewater Treatment Plants, Vols. I & II (WEF and ASCE joint publication).

4.5 Project Definition. The A-E shall prepare and submit a PD to the contracting officer. The PD is equivalent to a 10 to 15 percent design. The PD shall be used to apply for the WWTP final operating permits (par. 6.4). As soon as the PD has been prepared, the National Pollutant Discharge Elimination System (NPDES) permit applicant shall make contact with the proper regulatory agencies to ensure acceptance of the proposed treatment train and expedite the procurement of this permit (par. 4.14).

The designer will develop the detailed technical and functional aspects of the project consistent with RAMP planning requirements. WWTP site issues will be resolved and the parametric cost estimate validated and revised when necessary. These tasks are completed in the PD phase. A sample statement of work for PD can be found in CTL 90-1, Management of the MILCON Planning and Execution Process. User involvement during the PD phase is important and will help minimize later changes. All requirements, criteria such as ETLs, and scope are set during this phase and used to complete the design and prepare contract documents. The PD shall include, but is not limited to, the following elements:

a) A brief description of the wastewater treatment process train, including pretreatment, headworks, primary clarifiers, biological treatment, final clarifiers, disinfection, effluent disposal, and solids handling

b) Design criteria

c) Simplified process and instrumentation (P&I) diagrams

d) A preliminary wastewater plant hydraulic profile

e) Preliminary site planning

f) Preliminary site grading

g) Plant performance criteria (par. 4.7)

h) Negotiated discharge standards

4.6 Construction Documents. The A-E shall prepare design drawings, specifications, construction cost estimates, and other contract documents only after the approval of the PD by the AF DM. During this phase, the A-E shall provide, at a minimum, the following services:

a) Preparing construction drawings and specifications showing the character and extent of the project based on the approved PD document. Design review meetings are normally a part of this process.

b) Preparing an estimated total project cost based on the construction drawings and specifications (par. 4.13).

c) Furnishing all necessary engineering data required to apply for construction and regulatory permits from local, state, and Federal authorities.

d) Furnishing to the DA the specified number of copies of drawings, specifications, and other contract documents.

4.7 WWTP Performance Criteria. A POTW project built using EPA grant funds requires performance certification by law and regulation (Clean Water Act, Section 204[d]; 40 Code of Federal Regulations [CFR] 35.2218). The certification requirement was established to build high quality treatment works that comply with the enforceable requirements of the Clean Water Act. AF WWTP projects will also follow this performance quality concept.

4.7.1 Performance Certification. The A-E shall be responsible for developing detailed plant performance criteria. The A-E shall specify the range of discharge values expected from the project design. The range of input parameters shall be obtained from the base data used to develop the project design specifications. A performance test should be developed to demonstrate plant flexibility and performance under a range of input parameters and different weather conditions. The plant must meet final permit effluent quality limits under anticipated operational conditions. Some of the conditions and input parameters can be artificially created. Others, such as weather conditions, can be demonstrated only over a period of time. A performance certification report will be required from the A-E at the end of the performance period. The performance period should normally extend from 3 to 12 months.

4.7.2 Notification. Specifications should state that advance notice is required before startup and performance testing is initiated. Such notice will allow base civil engineering (BCE) personnel and operators to be present during startup and testing of the system components. The startup program is explained in par. 6.1.

4.8 O&M Manuals. The operation, maintenance, and repair information for the WWTP shall be incorporated into two separate manuals, a System Operating Manual and an Equipment Operating, Maintenance, and Repair Manual (EOM&RM). Guidelines for submission of these manuals will be in accordance with ETL 89-2, Standard Guidelines for Submission of Facility Operating and Maintenance Manuals. U.S. Army Corps of Engineers Regulation ER 25-345-1, Systems Operation and Maintenance Document, also addresses this requirement using a slightly different approach.

4.8.1 Manual Development Responsibilities. By definition, a WWTP is a complex system and requires two types of manuals. The A-E will develop the System Operating Manual. The contractor will provide the EOM&RM in accordance with instructions specified by the A-E.

4.8.1.1 System Operating Manual Submission. The A-E will provide to the DA the first draft of the System Operating Manual upon design completion. The final System Operating Manual shall be completed and submitted to the DA 60 days before the startup date. The DA will deliver the manual to the construction management section to be held until completion of the EOM&RM. The construction contractor shall complete the manual in accordance with the instructions specified by the A-E.

4.8.1.2 EOM&RM Submission. EOM&RMs will be prepared and submitted to the DA 30 days before the startup date. Copies of the approved manuals will be forwarded by the construction agent (CA) to the base construction management section, which will forward them, along with the System Operating Manuals, to the appropriate operations branch work centers.

4.8.1.3 Manual Format. Manuals shall be bound in three-post binders with tab dividers, in 8-1/2- by 11-inch format. Large drawings shall be folded and punched to fold out as bound or shall be inserted into a bound pouch. All written portions of manuals shall be provided in 3-1/2-inch floppy diskettes and shall be prepared in a word processing software specified by the AF DM. This information shall be prepared by the A-E for the System Operating Manual and provided by the contractor for the EOM&RM.

4.8.2 System Operating Manual Content. The System Operating Manual shall provide full and detailed information regarding the design criteria and sizing of facilities; standard operating procedures (SOPs); description and operation of unit processes; process troubleshooting; regulatory requirements, including reports and records; sampling and laboratory procedures; plant staffing; emergency operations; and safety and housekeeping procedures. Appendix I presents an example table of contents from a System Operating Manual. Also included in this manual shall be sections describing or explaining these elements:

a) P&I diagrams.

b) Single line drawings to show

(1) Color-coded piping for all treatment facility process lines indicating flow direction and location of all control valves and gates. A complete set of G-tab drawings--showing the locations of all base collection lines, lift stations, force mains, manholes, oil/water separators, and other unique facilities connected to the system--is normally maintained separately at the WWTP.

(2) A simplified electrical schematic of the control system and electrical equipment.

(3) Operating specifications for all pumping systems.

c) NPDES permit requirements, along with appropriate state and Federal regulations and reporting requirements. Information on stream water quality standards should also be provided for the discharge location.

d) The normal operating process of each component, along with an explanation of its relationship to the other components. Process control and monitoring instrumentation should be explained and control and valve status charts for the various operating modes should be included. The routine operator's tasks should be described. (See par. 7.5.)

e) Process theory and laboratory control testing and monitoring.

f) Safety issues and emergency operating procedures (in a separate chapter). Supporting utility systems and alternate power sources should also be described.

g) The requirements for daily operating logs and maintenance records.

h) Manpower requirements, along with job descriptions and training and certification requirements.

i) A list of technical references.

4.8.3 EOM&RM Content. The A-E or construction contractor shall prepare instructions based on the information provided by the equipment vendors in accordance with the construction specifications. The information must include performance sheets and graphs for the installed equipment, catalog cuts showing application information, installation information showing minimum acceptable requirements, O&M requirements, descriptions of starting and stopping procedures, repair information, and a parts list. Specifications shall direct the contractor to prepare the as-built master equipment list by adding the manufacturer's name, the address and phone number of the local representative, and the part/model/serial number to the design master equipment list (DMEL).

Appendix J includes an example table of contents from an EOM&RM. The chapter dedicated to Auxiliary Systems shall include service support systems not part of the wastewater treatment process but essential to keeping the process functioning as intended. This chapter shall address the following topics:

a) Potable water

b) Power distribution and standby

c) Heating, venting, and air conditioning

d) Fire protection and detection

e) Nonpotable water

f) Telephone and intercom

4.8.4 DMEL. The A-E shall also prepare a DMEL. The A-E DMEL shall include the item name, identification number, and construction specification section number for all major pieces of equipment.

4.9 Operator Training Program. The A-E shall be responsible for the preparation of the system operating training program and for the definition of contractor (equipment manufacturer) training requirements in accordance with the plans and specifications (see also par. 7.2.2). This requirement is also addressed in U.S. Army Corps of Engineers Regulation ER 25-345-1. Training is especially important for base operations but should be considered even if the WWTP will be contractor-operated. Training videos prepared during the training period would also be beneficial for later review and for new operators.

4.9.1 System Operating Training Plan. The A-E shall define system operating training requirements. The training may be implemented by the A-E or the construction contractor. The training plan should include training materials for formal training and for operator self-training courses. The A-E shall prepare the training program plan for the overall system and major components of the WWTP. The A-E shall detail the minimum number of hours and types of instruction to be provided for the overall system and for each subsystem. At a minimum, the BCE operations flight should review the training plan (par. 4.11). This training program plan shall include the following elements:

a) The names, background, and experience of each instructor who will participate in the formal implementation of the training program.

b) An on-site classroom training program. Training shall be conducted between the hours of 7:30 a.m. and 4:00 p.m., Monday through Friday, unless a different schedule is approved in writing by the contracting officer.

c) An on-site hands-on training program.

d) An off-site training program. Off-site training shall include visits to similar wastewater treatment facilities currently in operation, if feasible.

The A-E or contractor shall provide all equipment, material, and trained personnel necessary to visually and audibly record all field and classroom training sessions. The proposed recording system shall be of one manufacturer and of studio quality and shall be approved by the contracting officer prior to its use. Upon completion of training programs, three copies of the recordings shall be furnished to the contracting officer. The recording shall be identified, indexed, and placed in approved storage containers. This task may be excluded from the A-E contract if the base has capabilities to perform the work specified herein.

4.9.2 <u>Contractor Training Plan</u>. The A-E shall prepare training specifications detailing the minimum number of hours and types of instruction to be provided by the equipment manufacturer/vendor and contractor for each subsystem and piece of equipment warranting training. This specification shall require the following provisions:

a) Contractor-provided, qualified, competent instructors for formal training of Government operators

b) On-site classroom training

c) Off-site training, if needed

4.10 <u>Permit Applications</u>. The DA and DM are responsible for reviewing all construction permit applications (normally prepared by the A-E) and submitting them to the BCE for signature. The permit applications are then forwarded to the required regulatory agencies for approval and permit issuance. The base must also submit applications for a new or revised environmental operating (discharge) permit if the permit authority decides one is required for the new facility or to apply the new discharge limits. During this process, all correspondence shall be carefully documented and files retained by all parties for future reference. The project should not go to bid or award, nor should a Notice to Proceed be issued, until appropriate permit approval has been obtained or reasonable assurance of approval has been provided. The following permits may be needed for the WWTP project:

a) NPDES/State Pollution Discharge Elimination System permit (for construction and operation)

b) Local or regional connection application and pretreatment requirement certification, together with state indirect discharge permit or other permit to discharge to a POTW

c) Sewage lagoon, leaching fields, and septic tank permits

d) Stormwater runoff permit for the plant construction site

e) Air quality permit

4.11 Operator Participation During Design. During the design phase, the A-E shall make provisions for involvement and participation of the WWTP O&M staff. The DM, Construction Manager (CM), and O&M staff will form a review team. The major function of the team is to provide input or feedback to the A-E from review of the design of the facilities. All input and feedback will be coordinated through proper, established channels. The group shall provide input on the following issues, at a minimum:

a) Project definition

b) Construction documents

c) Monitoring process during construction

d) Preparation of O&M manuals

e) Training program

f) Plant startup

4.12 Design Reliability and Maintainability (R&M). The DA shall provide the A-E with a copy of ETL 88-4, R&M Design Checklist. The A-E shall complete all applicable sections of the checklist. The ETL contains design checklists for use in developing functional, reliable, and maintainable facilities and systems constructed by and for the AF. The objective of the ETL is to adequately address R&M during design. Low initial investment cost has traditionally been the overriding concern in new construction. This narrow view often results in high O&M costs, including manpower, over the life of the WWTP. The best way to include R&M considerations is to involve operations personnel in the design review (par. 4.11).

4.13 Project Construction Cost Estimate. The A-E is responsible for developing a detailed cost estimate for construction of the project. The estimate should include, but is not limited to, the following materials and services:

a) Materials for construction

b) Manpower for construction

c) Overhead

d) Travel

e) Value engineering

f) Title II inspection services

g) Preparation of regulatory permits

h) O&M requirements of facility (12 months)

i) Outside laboratory testing requirements in accordance with regulatory requirements

j) Design from A-E

k) Retaining a designer/consultant to provide services during the construction and startup period of the treatment facilities

l) Consumable items during operations (chemicals)

m) Preparation of O&M manuals

An initial cost estimate shall be prepared by the A-E and delivered to the AF Contracting Officer at the completion of the conceptual design (10 percent design phase). Another cost estimate, reflecting the changes during design, will be delivered to the AF Contracting Officer at the 100 percent design phase. A final cost estimate will be delivered to the AF Contracting Officer at the final inspection and it shall reflect the cost changes during construction.

4.14 Regulatory Agency Review. Federal, state, and local regulatory agencies must be contacted and afforded every opportunity to review and comment on the design package during the design stages. Their involvement will ensure compliance at all phases and help to control construction change orders as well as to keep the project on schedule and within budget. It will also facilitate final permit approvals. Meetings with regulators and any review comments must be recorded and the records must be retained. The DA, A-E, and base environmental staff must be involved in negotiating discharge standards with the regulators. All agreements, disagreements, and discussions with the regulators must be documented and included in the PD.

## Section 5: CONSTRUCTION

5.1 Construction Startup. The construction phase begins after the project has been approved, the construction permit has been obtained, and the construction contract has been awarded. A preconstruction/pre-performance conference is held at the job site to establish local ground rules covered by the contract (such as labor standards clauses), rules not covered by the contract (base regulations), and rules directly related to contractor actions and interactions on the base. Air Force Federal Acquisition Regulations Supplement (AFFARS) Subpart 5342.5 requires this conference. It is important for the DA and the base to obtain a construction permit from the appropriate regulatory agency prior to construction contract award. Plant operator involvement during the construction period is also beneficial. The lack of appropriate construction permits can result in project delays and contractor claims.

5.2 Permits and Clearances. The contractor shall obtain from the BCE the appropriate base permits or clearances for utilities, safety, and all base environmental issues. Wastewater treatment facilities may be operated under interim permit conditions. A construction permit can include a temporary operating permit issued for 6 months or longer for initial operation of the facility following substantial completion of construction. The construction contractor must comply with the terms of any applicable permits.

5.3 Title II Construction Services. It is desirable to retain the design A-E for Title II construction services and the initial performance period.

5.4 Operator Involvement During Construction. The CM should coordinate site visits for O&M personnel during construction to allow key operations personnel to become familiar with the location, controls, and operation of the systems and equipment. When the operations personnel identify concerns or deficiencies, these should be referred to the CM, the BCE, and, when necessary, the MAJCOM for resolution.

5.5 Construction Schedule. The construction schedule must include milestones. Critical permit application and approval dates, regulatory inspection time, and permit expiration dates should be indicated on this schedule. If the project completion date is driven by a Federal Facility Compliance Agreement, the DA must ensure the construction completion date meets the regulatory requirements.

## 5.6 As-Built Documentation and Record Drawings

5.6.1 Record Retention. The construction contractor shall maintain a record copy of the specifications at the site. A master equipment list, addenda, change orders, and shop drawings shall also be available. A set of full-size contract drawings must be marked to show any deviations made during construction and kept at the site. Any buried or concealed feature or utility revealed during the course of the construction must also be shown.

Special attention shall be given to recording all horizontal and vertical locations. This is important for all buried utilities that differ from the locations indicated or that were not indicated on the contract drawings. These record drawings shall be supplemented by detailed sketches, where needed or directed, to indicate fully the work as actually constructed.

5.6.2 Record Accessibility. Record drawings shall be accessible to the CM and the DA at all times during the construction period. A set of such record drawings shall be delivered to the DA within 15 days after completion. The DA is responsible for delivering a set of these drawings to the DM and BCE. These drawings shall be stamped "AS-BUILT DRAWING," "AS CONSTRUCTED," or "RECORD DRAWING."

## Section 6: INSPECTION COMMISSIONING

6.1 Startup Program. The design A-E or construction contractor is responsible for preparation of startup procedures for the WWTP. AF operators, construction contractor personnel, A-E operations staff, or contract operations personnel may be used to complete startup activities. The DM/CM will indicate which resources will be used for each particular project. Startup procedures shall be prepared and submitted to the DA/CA for approval by the DM/CM when construction is 90 percent complete. The following startup procedures, at a minimum, are required:

a) A plan and schedule to meet equipment and performance tests, including dates and test periods. The CA must know the test dates in advance to arrange for observation by interested base personnel.

b) Delivery of EOM&RM, spare parts lists, publications on the equipment and materials, and suppliers and service contacts.

c) Pre-startup training requirements to cover laboratory, classroom, and hands-on training.

d) A plan to bring the treatment system to the operational level.

6.2 Inspections (Prefinal and Final). All appropriate AF personnel must be notified about the date, time, and location of the prefinal and final inspections. These inspections will provide the final opportunity to question the construction contractor. AF treatment plant operations personnel will attend the inspections. The CA prepares a list of deficiencies, known as the "punch list," that were identified during the prefinal inspection. These items are to be corrected before the final inspection. The final inspection verifies that corrections have been made and that the project has been completed in accordance with the approved plans, specifications, and change orders. The final inspection is accomplished after the wet-run test.

6.3 Liability for Performance. After correction of the construction deficiencies and final inspection, meeting performance criteria is the primary responsibility of the design A-E. Meeting these criteria does not include correction of any latent construction deficiencies detected during the performance period. In any case, when responsibility is not clear, the CA must direct the contractor and designer to correct the deficiency and determine responsibility later.

6.4 Final Operating Permits. All permits shall be finalized and, when possible, obtained at least 60 days before the expiration date of the construction permit (par. 3.1). Permits may include, but are not limited to, the final NPDES permit, final air quality permit, fish and wildlife permit, and noise permit.

6.5 Dry and Wet Runs

6.5.1 Dry Run Inspection. Before the final inspection, the construction contractor shall conduct a dry-run inspection on installed equipment and systems. The manufacturer's representative, plant operator, and AF construction management representative shall attend. A form similar to the Pre-Startup Inspection Record included as Appendix K shall be used to document the dry-run inspection. This form shall be prepared by the A-E prior to the inspection and approved by the CM prior to the inspection.

During the inspection, the manufacturer's representative or construction contractor shall check the equipment for proper mounting, direction of rotation or travel, proper lubrication with the type of lubricants recorded and properly filed, clearances, alignments, undue noise and vibration, safety devices, and general operation. The contractor shall remove all rags, stones, paper, and other debris; check for obstructions in the piping; check all gates and valves for proper operation and seating; and ensure all safety chains and guards are in place. Malfunctions shall be scheduled for corrective action and time shall be arranged for the operator's dry-run training and the wet-run testing of the facilities.

6.5.2 Wet-Run Tests. The construction contractor shall conduct wet-run tests after the dry-run inspection and before the final inspection. The same form used in the dry-run inspection shall be used in the wet-run tests (Appendix K). Fresh water shall be used for the test. The test will include the following tasks:

a) Checking all piping and valves for leaks

b) Inspecting operation of all gates and valves

c) Inspecting all pumps

d) Operating all mechanical devices under hydraulic load

e) Inspecting disinfection facilities

f) Observing laboratory sampling and testing equipment

g) Checking all electronic/pneumatic instrumentation for proper operation.

h) Inspecting all flow meters, temperature and pressure indicators, and other sensors

i) Inspecting all weir levels and adjusting for startup

All deficiencies found during the inspection and testing should be corrected before startup. The contractor must demonstrate that all equipment is properly broken in, all equipment not to be used immediately is properly protected, and all laboratory equipment is inspected for proper calibration and operation. The A-E is responsible for providing the completed Pre-startup Inspection Record to the AF CA at the final inspection.

6.6 Facility Walk-Through. As soon as the plant is operating and AF facility acceptance has occurred, a ribbon-cutting ceremony followed by a walk-through should be scheduled. This walk-through will ensure understanding of the project by all concerned and will enhance community relations. Invited personnel should include, but not be limited to, MAJCOM Engineering; the Installation Commander; the BCE; the regional EPA representative; local and state regulators; local community leaders; the A-E representative; and the construction contractor.

## Section 7: PERFORMANCE COMMISSIONING

7.1 Post-Startup Program. Post-startup activities include confirming that the WWTP is operating as planned and establishing training programs and SOPs to ensure continued facility operation.

7.2 Training. The operator training programs prepared by the A-E during the design period shall be implemented during preparation for startup, during startup, and during the contract performance period, if necessary. The training process will be a continuous process and will include monitoring of WWTP staff performance. Additional training required or recommended by the A-E shall be added to the operator training program.

7.2.1 Training Responsibilities and Notice. Training will be conducted by the A-E, the construction contractor, the equipment vendors or their representatives, or a combination of these as approved in the training plan and specified in respective contracts. System and equipment O&M manuals should be delivered in advance (30 days minimum) and available for startup testing and training. Base operating personnel must be given advance notice (2 weeks minimum) of training to have time to adjust their schedules.

7.2.2 Scope of Training. All training conducted during the commissioning period shall consist of refining the skills required for routine and nonroutine O&M of the WWTP facilities. This training shall include, but not be limited to, the following categories:

a) Plant operation and process control

b) Plant maintenance procedures

c) Laboratory control - sampling and analysis

d) Records and reports

e) Emergency operating procedures

f) Management and administration

g) Maintenance management system

h) Inventory control system

i) Building and ground maintenance

j) Budgeting and cost accounting

k) Plant electrical systems

l) Safety

m) Computer and control systems

n) Industrial user monitoring

7.3 WWTP Operation Performance Period. The design A-E or construction/operations contractor shall be responsible for the O&M of the WWTP during the required performance period. The A-E or contractor shall demonstrate efficient operation of the WWTP, in compliance with the project performance standards. Assignment of O&M responsibility during the performance period may vary from project to project, depending on the size, type, and complexity of the project and the needs of the AF. Typical A-E or construction/operation contractor responsibilities may include, but are not limited to, the following tasks:

a) Directing the operation of the treatment works. (Note: to "direct" does not mean to establish a daily "in charge" presence at the treatment works or to assume the role of employee supervisor or chief operator.)

b) Revising the O&M manual to reflect actual operating experience.

c) Training operators.

d) Providing engineering consultation.

e) Reviewing laboratory procedures.

f) Conducting periodic site visits to ensure proper operations on smaller WWTPs.

g) Checking process units, sewers, facilities, flows, etc., to ensure proper operation.

h) Preparing ongoing records of plant performance, including tables and graphs monitoring influent quantity and quality, effluent quality, and unit processes control parameters.

7.4 Performance Certification. The plant performance criteria developed by the design A-E during design of the facilities shall be tested, and a performance certification report prepared in accordance with par. 4.7. During the performance period, the design A-E shall observe and evaluate plant operations and provide advice and assistance to achieve satisfactory plant performance. The design A-E shall advise the AF if the project is meeting performance standards. If it is not, the A-E shall provide the reasons for not meeting these standards. The design A-E shall be responsible for any corrective action necessary to bring the project into compliance with performance criteria. Liability for performance is discussed in par. 6.3. If plant operation does not meet the criteria, the A-E shall prepare and submit the following items:

a) A corrective action report. This report shall include an analysis of the cause of the project's failure to meet the performance criteria and an estimate of the nature, scope, and cost of corrective action required to bring the project into compliance.

b) A schedule for undertaking corrective action in a timely manner.

c) The scheduled date by which the A-E will be able to certify the project meets performance criteria.

At the end of the performance period, and after performance certification, the AF accepts responsibility for the WWTP. Following the guidance in this handbook will ensure the A-E has met the design and performance requirements.

7.5 SOPs

7.5.1 SOP Submission. The A-E shall provide the contracting officer a draft of the SOPs at 50 percent construction completion and the final draft of the SOPs 30 days prior to construction completion. At the end of the performance period, the A-E shall also provide a site-tested, final SOP for each major component of the treatment plant.

7.5.2 Processes Requiring SOPs. The SOPs are part of the system O&M manuals (par. 4.8.2) and may require revision to reflect actual operating experience. SOPs shall be prepared for all processes including, but not limited to, those listed below:

a) Pumping stations

b) Screening removal and disposal

c) Grit removal

d) Primary treatment

e) Biological treatment

f) Advanced treatment

g) Sludge handling system

h) Tank drainage system

i) Fuel storage and distribution system

j) Potable water system

k) Plant water system

l) Power distribution system

m) Standby power system

7.5.3 Elements of SOPs. Each SOP shall contain, at a minimum, the following elements:

a) A component numbering identification system for each valve, control point, and unit process

b) Descriptions of normal valve settings, flow diversions, and operational requirements

c) Descriptions of routine operating procedures including startup, break-in, normal operation, regulating, controlling, stopping, shutdown, emergency, special visual observations, and recordkeeping

d) Descriptions of routine safety procedures and potential danger areas

7.5.4 SOP Format. One final set of SOPs shall be printed on durable 8-1/2- by 11-inch paper. Graphics, photos, and illustrations shall be used to the greatest practical extent. The SOPs shall not be more than 10 pages in length each, and shall be ring-bound with a plastic protective cover. All written portions of the SOPs shall be provided to the contracting officer on a 3-1/2-inch diskette and shall be prepared in a word processing software specified by the AF DM.

7.6 O&M Service Contract Documentation (Optional). The A-E shall prepare contract documents for use by the Government in the solicitation of bids from qualified contractors. These documents will cover O&M of the WWTP for the base period in full compliance with regulatory requirements. Two optional periods of 12 months each shall be included in the bid package. These service contract documents shall include, but not be limited to, the performance work statement, the bid form, and the cost estimate.

7.6.1 Performance Work Statement. The performance work statement will address these topics:

a) Equipment and facilities operation, maintenance, and repair, in accordance with O&M manuals (par. 4.8.3)

b) Building and facility maintenance in accordance with O&M manuals (par. 4.8.3)

c) Staffing and training requirements

d) Government-furnished services and property

e) Tools and spare parts in accordance with O&M manuals (par. 4.8.3)

f) Consumable requirements, including chemicals and fuels

g) Permit requirements

h) Analytical testing requirements

7.6.2 Bid Form. The bid form shall list unit price items, for major components only, for the base period. Unit price items for the O&M of major components shall be listed on a monthly basis for the base period and for the two optional periods of 12 months each.

7.6.3 Cost Estimate. The A-E shall develop an estimate for the cost of operating and maintaining the WWTP for a 12-month period. The cost estimate shall be prepared on a cost-per-month basis.

APPENDIX A
WASTEWATER TREATMENT PLANT MANAGEMENT CHECKLIST

| WASTEWATER TREATMENT PLANT MANAGEMENT CHECKLIST | | DATE: ____ | | | PAGE 1 OF 4 |
|---|---|---|---|---|---|
| PROJECT NAME: | | BY: ____ | | | |
| PARAGRAPH No. | DESCRIPTION | DATE COMPLETED | | RESPONSIBILITY | COMMENT No. |
| | | SCHEDULED | ACTUAL | OFFICE/PHONE | |
| **2** | **Facilities Planning** | | | | |
| 2.2 | Requirement identification (BCP, NOV, ECAMP) | | | OPR:<br>OCR: | |
| 2.3 | Problem definition | | | OPR:<br>OCR: | |
| 2.3.2 | Regulatory requirements review | | | OPR:<br>OCR: | |
| 2.3.3 | Additional engineering studies | | | OPR:<br>OCR: | |
| 2.4 | A-106 report | | | OPR:<br>OCR: | |
| 2.5 | Environmental compliance funding | | | OPR:<br>OCR: | |
| **3** | **Programming** | | | | |
| 3.2 | Requirements and Management Plan (RAMP) | | | OPR:<br>OCR: | |
| 3.3 | Engineering studies review | | | OPR:<br>OCR: | |
| 3.4 | Future requirements review | | | OPR:<br>OCR: | |
| 3.5 | Evaluation of alternatives | | | OPR:<br>OCR: | |
| 3.6 | EA/EIS Initiation | | | OPR:<br>OCR: | |

APPENDIX A (Continued)

| WASTEWATER TREATMENT PLANT MANAGEMENT CHECKLIST | | DATE: ________ BY: ________ | | | PAGE 2 OF 4 |
|---|---|---|---|---|---|
| PROJECT NAME: | | | | | |
| PARAGRAPH No. | DESCRIPTION | DATE COMPLETED SCHEDULED | DATE COMPLETED ACTUAL | RESPONSIBILITY OFFICE/PHONE | COMMENT No. |
| 3.7 | DD Form 1391 and supporting documents | | | OPR:<br>OCR: | |
| 3.8 | Determine facility requirements (size, space, automation, etc.) | | | OPR:<br>OCR: | |
| 3.9 | Regulatory agency participation | | | OPR:<br>OCR: | |
| 4 | **Design** | | | | |
| 4.5 | Project definition completed | | | OPR:<br>OCR: | |
| 4.6 | Construction documents | | | OPR:<br>OCR: | |
| 4.7 | WWTP performance criteria | | | OPR:<br>OCR: | |
| 4.8 | O&M manuals | | | OPR:<br>OCR: | |
| 4.9 | Operator training program | | | OPR:<br>OCR: | |
| 4.10 | Permit applications | | | OPR:<br>OCR: | |
| 4.11 | O& M operator review and participation during design | | | OPR:<br>OCR: | |
| 4.12 | Design reliability and maintainability | | | OPR:<br>OCR: | |

APPENDIX A (Continued)

| Wastewater Treatment Plant Management Checklist | | Date: ______ | | | Page 3 of 4 |
|---|---|---|---|---|---|
| Project Name: | | By: ______ | | | |
| Paragraph No. | Description | Date Completed: Scheduled | Date Completed: Actual | Responsibility Office/Phone | Comment No. |
| 4.13 | Project construction cost estimate | | | OPR:<br>OCR: | |
| 4.14 | Regulatory agency review | | | OPR:<br>OCR: | |
| **5** | **Construction** | | | | |
| 5.2 | Construction permit approved | | | OPR:<br>OCR: | |
| 5.3 | Title II construction services | | | OPR:<br>OCR: | |
| 5.4 | Operator involvement during construction | | | OPR:<br>OCR: | |
| 5.5 | Construction schedule | | | OPR:<br>OCR: | |
| 5.6 | As-built documents | | | OPR:<br>OCR: | |
| **6** | **Inspection Commissioning** | | | | |
| 6.2 | Completion of construction and prefinal inspection | | | OPR:<br>OCR: | |
| 6.3 | Liability for performance | | | OPR:<br>OCR: | |
| 6.4 | Final operating permits | | | OPR:<br>OCR: | |

APPENDIX A (Continued)

| WASTEWATER TREATMENT PLANT MANAGEMENT CHECKLIST | | DATE: ______ | | | PAGE 4 OF 4 |
|---|---|---|---|---|---|
| PROJECT NAME: | | BY: ______ | | | |
| PARAGRAPH No. | DESCRIPTION | DATE COMPLETED | | RESPONSIBILITY | COMMENT No. |
| | | SCHEDULED | ACTUAL | OFFICE/PHONE | |
| 6.5 | Dry-run inspection and wet-run test | | | OPR:<br>OCR: | |
| 6.2, 6.5 | Final inspection | | | OPR:<br>OCR: | |
| 6.6 | Ribbon cutting and facilities walk-through | | | OPR:<br>OCR: | |
| 7 | **Performance Commissioning** | | | | |
| 7.2 | Training program implementation | | | OPR:<br>OCR: | |
| 7.3 | WWTP operation performance period | | | OPR:<br>OCR: | |
| 7.4 | Performance certification | | | OPR:<br>OCR: | |
| 7.5 | Standard operating procedures (SOPs) | | | OPR:<br>OCR: | |
| 7.6 | Operation and maintenance service contract documentation (optional) | | | OPR:<br>OCR: | |

Federal Guidelines

# Design, Operation and Maintenance

of Waste Water Treatment Facilities

September 1970

U.S. DEPARTMENT OF THE INTERIOR • FEDERAL WATER QUALITY ADMINISTRATION

PB-215 494

FEDERAL GUIDELINES - DESIGN, OPERATION AND MAINTENANCE OF WASTE WATER TREATMENT FACILITIES

Federal Water Quality Administration
Washington, D. C.

September 1970

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## FOREWORD

Effective design and operation of municipal waste water treatment facilities is an essential element in the preservation and enhancement of our Nation's waters. The tremendous investment of Federal, State, and local funds in these facilities must be protected. We must incorporate past experience and new technology in this generation of facilities to ensure that optimum benefits are derived from expenditures in water pollution control. The development of these Guidelines represents a significant step toward the achievement of these goals.

Many have contributed to the development of these Guidelines. I particularly wish to thank the Ad Hoc Advisory Group, composed of representatives of the American Society of Civil Engineers, the Association of Metropolitan Severage Agencies, the Association of State and Interstate Water Pollution Control Administrators, the Great Lakes-Upper Mississippi Board of Sanitary Engineers, the U. S. Council of Consulting Engineers, the Water and Wastewater Equipment Manufacturers' Association, and the Water Pollution Control Federation, for their advice and counsel in reviewing the Guidelines and in developing the general procedures.

David D. Dominick, Commissioner
Federal Water Quality Administration

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APPENDIX B (Continued)

INTRODUCTION

Over the past year the Federal Water Quality Administration has carefully analyzed and evaluated its grant program for the construction of waste treatment facilities. Past experience indicated that some of the projects that have received assistance have, for a variety of reasons, not always been as successful as anticipated. Improved design practices and technological advances are not being adequately incorporated into new plants. Operators are often poorly trained and paid. Facilities are frequently badly maintained and achieve far less than their designed efficiency levels.

FWQA has an obligation to ensure that Federal monies are wisely spent. This Administration must insist on proper design and operation procedures as it is clear that without them adequate levels of treatment will not be obtained.

On February 10, 1970, President Nixon announced a 37 point program to improve the Federal government's environmental protection programs. In this message he directed the Secretary of the Interior to require that Federally-assisted treatment facilities meet prescribed design, operation and maintenance standards. Only July 2, 1970, the Department of the Interior issued new regulations for the construction grants program to implement the President's directive. Section 601.35 of Title 18 of the Code of Federal Regulations concerns the area of operation and maintenance of facilities; Section 601.36 concerns the design of facilities.

Section 601.36 states that "no grant shall be made for any project unless the Commissioner determines that the proposed treatment works are designed so as to achieve economy, efficiency, and effectiveness in the prevention or abatement of pollution or enhancement of the quality of the water into which such treatment works will discharge and meet such requirements as the Commissioner may publish from time to time concerning treatment works design so as to achieve efficiency, economy and effectiveness in waste treatment."

There are existing manuals, such as the various State and interstate standards and the ASCE-WPCF manuals, which can be used as references in the design of water pollution control facilities. Although these are generally adequate, it is important to emphasize that FWQA is not necessarily in full agreement with all criteria and concepts contained therein. Certain design considerations are not adequately emphasized, and adequate guidance is not given in those areas where there have been recent technological advances.

To supplement the existing standards, FWQA has developed Guidelines for Design. These Guidelines are not intended to cover all aspects of engineering design. Rather they outline, generally in broad terms, specific FWQA interests and policies that are not adequately reflected in the presently existing manuals.

In addition to these Guidelines, FWQA will be issuing Technical Bulletins. Each Bulletin will cover a certain topic in detail. These Bulletins are intended to amplify specific areas contained in the Guidelines, define and analyze certain deficiencies in design, and evaluate new advances in technology and provide guidance for incorporating these in new facilities. The Bulletins will combine the results of our field experience and our research and development program, along with the efforts of outside experts and consultants.

Together with the applicable portions of presently existing manuals and the attached Guidelines, the Technical Bulletins will cummulatively constitute the FWQA design requirements referred to in Section 601.36.

Section 601.35 states that "no grant shall be made for any project unless the State water pollution control agency assures the Commissioner that the State will inspect the treatment works not less frequently than annually for the 3 years after such treatment works are constructed and periodically thereafter to determine whether such treatment works are operated and maintained in an efficient, economic, and effective manner and unless the applicant assures the Commissioner that the treatment works will be maintained and operated in accordance with such requirements as the Commissioner may publish from time to time concerning methods, techniques, and practices for economic, efficient, and effective operation and maintenance of treatment works."

The number and frequency of the inspections called for by the regulation are the absolute minimum necessary to ensure proper maintenance and operation of a facility. FWQA will be working closely with the States to ensure that inspections are adequate in scope as well as in frequency.

FWQA has developed Guidelines for Operation and Maintenance which provide the general basic requirements in the areas of inspections, operation and maintenance for Federally-assisted projects. FWQA will be issuing Technical Bulletins which, as in the case of the Technical Bulletins for Design, will provide amplifications in certain specific areas.

The Guidelines and future FWQA Technical Bulletins for design and operation and maintenance should be maintained in appropriate files by State water pollution control agencies, consulting engineers, and all other interested parties. In the future, projects for which Federal grant assistance is requested are expected to comply with these Guidelines and Technical Bulletins. While in exceptional cases deviations may be accepted, any deviations must be justified on a case-by-case basis and approved by FWQA prior to their initiation.

## GUIDELINES FOR DESIGN

These Guidelines are intended to supplement existing references such as the Recommended Standards for Sewage Works: Great Lakes-Upper Mississippi River Board of State Sanitary Engineers (the Ten State Standards), the ASCE Manuals Number 36 and 37 (WPCF Manuals 8 and 9), and applicable State standards and guidelines.

All water pollution control projects which are submitted for FWQA construction grants will be required to conform to these Guidelines and future Technical Bulletins, as well as to applicable State requirements. It is recognized that certain modifications or exceptions may be necessary when justified in unusual situations. In such cases under appropriate conditions, deviations from existing standards or Guidelines may be allowed. However, written approval of any deviations from the Guidelines, Technical Bulletins, or applicable State standards must be obtained from the FWQA Regional Office and the State agency as early as possible prior to the completion of detailed plans and specifications.

These Guidelines are presented in two parts. Part A deals with general concepts which must be considered very early in the planning and preparation of an engineering report for waste treatment facilities. Part B makes reference to more specific subjects which must be considered in the preparation of final construction plans and specifications.

PRELIMINARY PROJECT PLANNING AND ENGINEERING REPORT

Certain basic principles should be considered early in the planning process for water pollution control facilities. Conformance with these principles is essential to ensure the eventual development of properly designed facilities which will meet all State and FWQA requirements.

The engineering report accompanying the application for Federal aid should clearly indicate compliance with the following principles. Any questions regarding the applicability of these items to the proposed project or requests for deviations should be resolved by consultation with the State water pollution control agency and the FWQA Regional Office before completion of the engineering report and submission of an application for Federal aid.

I. Environmental Compatibility

All Federally-assisted projects must conform to the intent of the National Environmental Policy Act of 1969 and Executive Order 11514, Protection and Enhancement of Environmental Quality.

a. Planning for the proposed project must take into account all aspects of environmental quality protection. Efforts shall be taken to preserve natural beauty, wildlife, recreational areas, historic sites, and private property.

b. The project must be designed and constructed so as to have the least possible impact on the environment.

c. Attention must be given to the general aesthetic appearance of the facility and to the prevention of any possible odor problems.

d. Planning shall be coordinated with local planning and citizen groups to resolve potential site problems.

e. Plant locations on flood plains should be avoided whenever practicable. When such locations are unavoidable, adequate protection from flooding must be provided.

II. Regionalization

a. Due consideration must be given to the advantages of regional and basin sewerage facility planning. Whenever feasible, municipalities should join together in cooperative regional treatment systems, composed of one or more treatment plants depending on water quality requirements and economic, operational, and other appropriate considerations.

b. Where regional waste water management plans have been developed and approved by an appropriate agency, the project should conform to such plans.

c. If a regional plan has not been developed, an analysis shall be made to determine the feasibility of having the municipality join in a regional system in lieu of constructing their own independent or additional treatment facilities.

III. Project Feasibility

a. After consideration of all alternatives, the design of the proposed project shall be made on the basis of economic feasibility, water quality objectives, environmental compatibility, and other applicable considerations. That certain portions of the system are eligible for Federal assistance and others are not should not determine the final nature of the project.

b. In order to avoid tying up Federal grant funds for unreasonably long periods of time, the project for which Federal aid is requested, including other facilities required to make it operable, should be of such a scope that it can be completed and in operation within three years of the date of the Federal grant offer. For unusually large and complex projects, a longer period of time may be allowed. Additional phases of the project may be submitted for consideration for Federal aid in future years when the anticipated construction period will meet these requirements.

IV. Complete and Operable Treatment Works

a. Any proposed project must be designed and reviewed in light of the entire waste treatment system. No project will be approved unless it is shown that the capacity and treatment provided by the waste treatment system serving the proposed project will meet all FWQA, State, and interstate requirements, including approved water quality standards, and protect the designated uses of the receiving waters.

b. If construction of other facilities is required to make the proposed project operable and acceptable, then a commitment must be made that the required construction will be concurrent with that of the proposed facility.

V. Receiving Waters and Degree of Treatment

a. Proposed treatment must be in accordance with State requirements, as well as with Federal and State water quality standards, Federal Enforcement Conference requirements, comprehensive river basin reports and plans, FWQA Regulations, and the designated uses of the receiving waters.

b. Characteristics of receiving waters must be considered to ensure that water quality standards will be met by the proposed treatment. Applicable data shall be included in the engineering report.

c. The engineering report shall specifically indicate the anticipated removal efficiency of BOD, suspended solids, and other appropriate parameters, and the total pounds of BOD, suspended solids, and other significant constituents to be discharged per day.

d. There should be no discharge of effluents to swamps, stagnant waters, small lakes, or intermittent streams if feasible alternates are available.

e. Outfalls shall be extended and designed as necessary to insure adequate mixing and dispersal of the effluent.

f. Disposal of a treated effluent to other than surface waters requires prior approval from the State and FWQA.

VI. Ultimate Disposal of Sludge and Solids

a. Provision for ultimate disposal of sludge must be clearly indicated and must be in accordance with interstate, State, and FWQA requirements. It is not sufficient merely to indicate such processes as drying beds, vacuum filters, or incinerators, without also describing the method to be used for final disposal of the sludge cake or sludge residues.

b. The method of final disposal must not result in any significant degradation of surface or ground water, air, or land resources. If there is a choice, the method chosen must be that having the least impact on the environment.

c. No sludge residues, grit, ash, or other solids may be discharged into the receiving waters or plant effluent. The disposal of any sludge to ocean waters is not recommended.

d. Disposal of raw sludge to fresh or marine waters or by spreading and tilling on land will not be approved.

e. Sludge elutriation is not considered desirable and will not be approved without adequate safeguards.

VII. Treatment Plant Reliability

a. All water pollution control facilities should be planned and designed so as to provide for maximum reliability at all times.

b. The facility should be capable of operating satisfactorily during power failures, flooding, peak loads, equipment failure, and maintenance shutdowns. A minimum of primary treatment should be provided at all times. Disinfection and higher degrees of treatment may be required where necessitated by the uses of the receiving waters.

c. Such reliability can be obtained through the use of various design techniques which will result in a facility which is virtually "fail-safe." (See Part B, Section II, page 20.)

VIII. Excessive Infiltration

a. Excessive infiltration is an indication of deficiencies in the sewerage system. This situation is often categorized by high per capita flows to the treatment facility.

b. Construction of treatment facilities with extra capacity to handle these excessive flows may not be the best solution to the problem, since this may result in unnecessary capital and operating costs and in inefficient treatment.

c. An analysis of the sewerage system must be made to determine the causes for such excessive infiltration where it occurs and, where feasible, an acceptable remedial plan of action should be prepared to correct the situation.

d. Solutions, such as separation of illegal storm water connections, repair or replacement of defective sewers, and enforcement of sewer ordinances, must be discussed in the report together with an adequate cost analysis before any recommendation is made to construct an oversized treatment facility or to allow by-passing of excess flows.

IX. Elimination of By-passing

a. In systems handling only dry-weather flows, the incorporation in the design of mechanisms for by-passing treatment plants or pumping stations must be avoided if at all possible. Any exceptions must have prior approval of the State and FWQA.

b. Where incorporation of by-passing facilities is necessary, consideration must be given to separation of combined systems, detention facilities, or other alternative means of control or treatment, and disinfection of overflows.

c. Adequate safeguards to prevent misuse of by-pass facilities must be provided.

d. Extended by-passing during construction will not be permitted. (See Part B, Section IV, page 21.)

X. Industrial Wastes

a. The engineering report should clearly define the characteristics of the wastes from major or significant industries and their effects upon the waste treatment process.

b. Where necessary, pilot plant studies should be made to determine the final design criteria for the treatment facility.

c. It is necessary that adequate industrial waste ordinances or other controls be adopted by the municipalities in order to protect and maintain the treatment facilities. These shall provide for the following:

1. Pretreatment of any wastes which would otherwise be detrimental to the collection system, treatment facilities, or processes.

2. An equitable system of cost recovery in accordance with Federal Regulations, 18 CFR 601.34c.

## XI. Staffing and Budget for a Facility

A thorough analysis must be made of the operation and maintenance requirements of the proposed facility, including required laboratory testing. Specific recommendations shall be given in the engineering report for staffing, including operator qualifications, and annual budget needs of the proposed treatment facility.

XII. Design Period

A careful review of the growth potential of the area to be served by a waste water facility should be made to adequately provide for the increased waste loadings that are expected to develop. Both domestic and industrial loadings should be discussed in the report. It is not considered feasible for FWQA to establish a standard minimum design period because the growth characteristics of a particular area may be such that a minimum design period would cause uneconomical design and inefficient operating conditions after the project is constructed The rationale for design will be as follows:

a. When rapid growth is anticipated, the design period should be long enough for orderly spacing of construction contracts and the design should permit sufficient flexibility to prevent inefficient operation of individual units. The design layout of a treatment facility should consider the ultimate development of the watershed being served and the characteristics of the receiving waters. Construction may be phased to meet treatment demands.

b. Where the anticipated growth of an area is estimated to be relatively slow, the design should be for a reasonable growth rate with sufficient flexibility of sizing of units to ensure efficiency of operation.

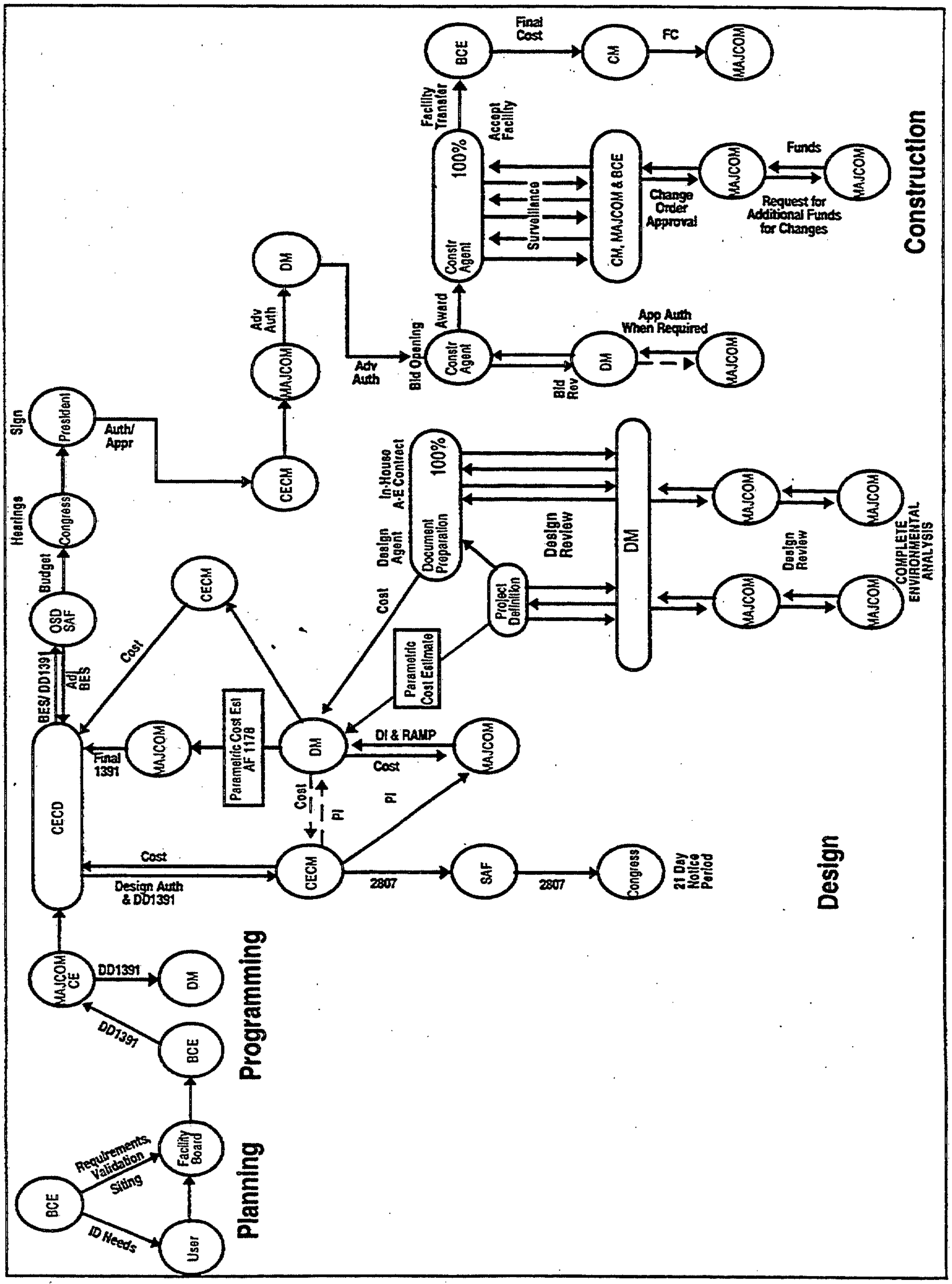
c. The plant site must be sufficiently large to permit expansion of the facility to provide for foreseeable future needs, such as increased capacity and higher degrees of treatment.

d. The plant must be designed to facilitate expansion and possible upgrading of the facility.

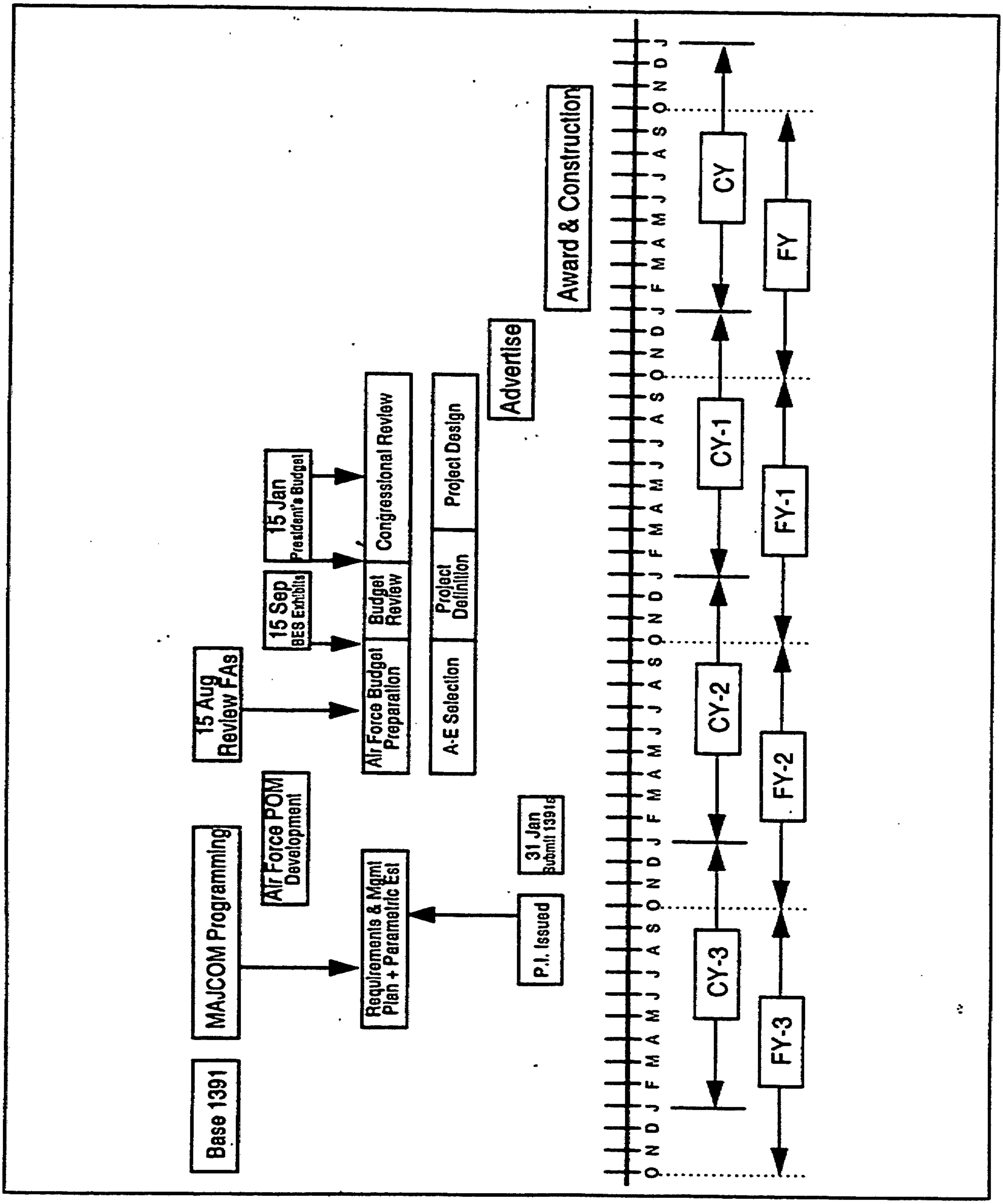
XIII. Combined Sewerage Systems

The problem of pollution from combined systems shall be considered in early project planning. Possible solutions, both short and long term, shall be outlined in the engineering report. Consideration shall be given to detention facilities and disinfection, separation of combined systems, treatment or control of overflows or other solutions.

# APPENDIX C
# MILCON CYCLE FLOWCHART



APPENDIX D
MILCON PROCESS DIAGRAM



# CAPDET-PC

**A Computer Program for the Design and Cost Estimation of Wastewater Treatment Facilities**

**Hydromantis, Inc.**

# CAPDET-PC

## What Is CAPDET?

CAPDET-PC is a computer-based design and cost estimation procedure for the identification of wastewater treatment alternatives. CAPDET-PC is a full-fledged implementation of the CAPDET program originally developed jointly by the U.S. EPA and the U.S. Army Corps of Engineers for large mainframe computers. A typical CAPDET-PC treatment scheme consists of individual unit processes, selected from a library of more than 60 unit processes, ranging in complexity from preliminary treatment to advanced physico-chemical processes. CAPDET-PC can handle up to four treatment schemes in any given run. Each scheme contains a liquid line, along with primary, secondary, and/or chemical sludge lines. CAPDET-PC can be used for the analysis of new treatment plants or to study the expansion and upgrading of existing facilities. CAPDET-PC consists of two independent modules:

a) CAPDET(lg)-PC for large wastewater treatment facilities with flows in excess of 0.5 MGD; and

b) CAPDET(sm)-PC for small systems with flows under 0.5 MGD and for land treatment systems.

## Input Requirements

CAPDET-PC is easy to use. The user defines a treatment scheme simply by listing the treatment processes that make up the desired treatment plant and by specifying the wastewater flow rate. A typical treatment scheme along with the appropriate coding is shown in this brochure. An extensive default database is contained in CAPDET-PC to generate preliminary designs. However, the user can refine his/her design by providing site-specific data for:

- wastewater influent characteristics;
- unit process design criteria; and
- unit cost data.

The following parameters are considered in CAPDET-PC:

| | |
|---|---|
| Suspended solids | pH |
| Volatile solids | Cations |
| Settleable solids | Anions |
| $BOD_5$ | $PO_4$ |
| Soluble BOD | TKN |
| COD | $NH_3$ |
| Soluble COD | $NO_2$; $NO_3$ |
| Temperature | Oil & Grease |

## Program Output

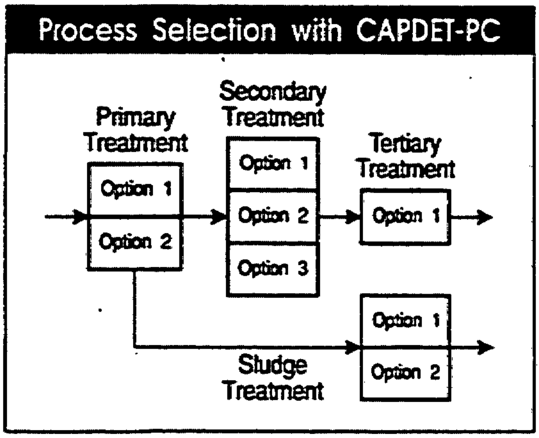
CAPDET-PC goes through the typical engineering calculations that would be performed in designing a wastewater treatment plant. In addition, CAPDET-PC provides data on the physical plant by evaluating construction quantities such as volume of excavation, volume of concrete, number of pumps, size and number of blowers, etc. These quantities are used in CAPDET-PC's unique cost estimation algorithm. CAPDET-PC calculates pollutant removal, evaluates sludge production, generates preliminary design and material quantities, and provides construction and O&M cost estimates. Performance and quantity reports are generated for every treatment process in a wastewater treatment plant.
The user-specified influent is sequentially run through each of the unit processes included in the liquid line. The user can control the treatment efficiency by changing the default process variables in order to reflect the performance of the equipment selected, e.g., overflow rate, detention time, chemical dosages, etc.

## Cost Estimation

Construction costs and O&M costs associated with the individual treatment processes are estimated using a 'unit-cost' approach. This costing technique is site-specific and can be used to account for time factors such as inflation. The user has the option of: a) updating the default unit costs with cost indices; or b) supplying his own unit costs. CAPDET-PC can generate the total construction cost through the use of built-in parametric equations to estimate the cost component of the associated facilities such as yard piping, site electrical works, instrumentation and control, etc.

## Treatment Train Selection

CAPDET-PC offers the possibility of analyzing a combination of treatment processes at any given point along the treatment scheme. For example, in the following figure CAPDET-PC would analyze 12 treatment trains (2x3x1x2) and would rank them according to user-specified criteria, e.g., total annual cost, O&M costs, or energy consumption.



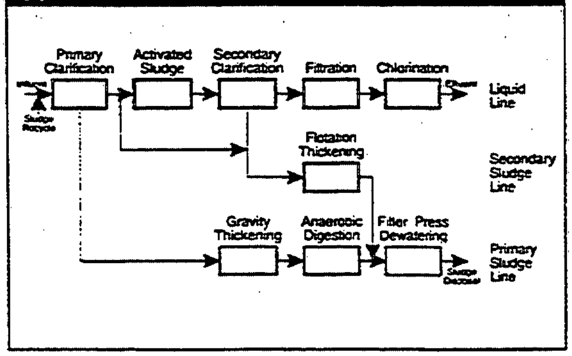

## Treatment Processes

| | CAPDET (lg)-PC | CAPDET (sm)-PC |
|---|---|---|
| **Wastewater Treatment** | | |
| **Biological Treatment** | | |
| aerated lagoon | x | x |
| attached growth denitrification | x | |
| suspended growth denitrification | x | |
| complete mix activated sludge | x | |
| contact stabilization activated sludge | x | |
| extended aeration activated sludge | x | |
| high rate activated sludge | x | |
| lagoon | x | x |
| suspended growth nitrification | x | |
| rotating biological contactor | x | |
| step aeration activated sludge | x | |
| trickling filter nitrification | x | |
| oxidation ditch | x | |
| plug flow activated sludge | x | |
| pure oxygen activated sludge | x | |
| rotating biological contactor nitrification | x | |
| step aeration activated sludge | x | |
| trickling filtration | x | x |
| package plant activated sludge | | x |
| septic tanks | | x |

APPENDIX E (Continued)

| | CAPDET (lg)-PC | CAPDET (sm)-PC |
|---|---|---|
| **Physico-chemical Treatment** | | |
| coagulation | x | x |
| primary clarification | x | x |
| secondary clarification | x | |
| counter current ammonia stripping | x | |
| cross current ammonia stripping | x | |
| equalization | x | x |
| filtration | x | x |
| flotation | x | x |
| anion exchange | x | |
| chlorination | x | x |
| cation exchange | x | |
| carbon absorption | x | |
| microscreening | x | |
| neutralization | x | |
| preliminary treatment | x | |
| post-aeration | x | x |
| intermediate pumping | x | |
| raw sewage pumping | x | x |
| recarbonation | x | |
| two-stage lime treatment | x | |
| bar screens | | x |
| intermittent sand filtration | | x |
| pumping | | x |
| sewer interceptor | x | x |
| **Land Treatment** | | |
| overland flow | | x |
| rapid infiltration | | x |
| slow infiltration | | x |
| **Sludge Treatment** | | |
| aerobic digestion | x | |
| air flotation thickening | x | |
| anaerobic digestion | x | |
| belt filter dewatering | x | |
| centrifugation | x | |
| drying beds | x | x |
| filter press dewatering | x | |
| fluidized bed incineration | x | |
| gravity thickening | x | |
| hauling and landfilling | x | |
| multiple hearth incineration | x | |
| sludge drying lagoons | x | |
| vacuum filtration | x | |
| wet oxidation | x | |
| drying lagoon | | x |
| composting | x | x |
| land application | x | x |

Typical CAPDET-PC Treatment Scheme




Typical Input File

```
TITLE                    Sample
LIQUID
BLOCK                    PRIMAR
BLOCK                    COMPLE
BLOCK                    FILTRA
BLOCK                    CHLORI
SECONDARY SLUDGE
BLOCK                    AIR FL
BLOCK                    C MIX
PRIMARY SLUDGE
BLOCK                    GRAVIT
BLOCK                    ANAERO
BLOCK                    FLTR P
WASTE INFLUENT
AVERAGE FLOW 5.0 MGD
MINIMUM FLOW 3.0 MGD
MAXIMUM FLOW 7.0 MGD
DESIRED EFFLUENT
UNIT COSTS
MOBILIZATION
LAB AND ADMIN BUILDING
CLEARING AND GRUBBING
END
CONTROL CARDS
OUTPUT QUANTITIES
ANALYZE
GO   INTEREST = 6.625          DESIGN LIFE 20 YEARS
```

APPENDIX E (Continued)

## Typical Process Output

### Complete Mix Activated Sludge

| | | |
|---|---|---|
| D | Reaction rate constant | .135E-02 L/mg-h |
| D | Sludge produced per BOD removed | .730E+00 |
| D | Endogenous rate (oxygen basis) | .150E-00 /day |
| D | $O_2$ utilized per BOD removed | .520E+00 |
| D | Endogenous rate (sludge basis) | .750E-01 /day |
| D | Influent non-degradable VSS | .400E+00 |
| D | Effluent degradable VSS | .530E+00 |
| D | lb BOD/lb MLSS-day | .500E+00 |
| D | Mixed liquor SS | .450E+04 mg/L |
| D | Mixed liquor VS | .315E+04 mg/L |
| | Aeration time | .564E+01 hours |
| | Volume of aeration tank | .120E+01 MG |
| | Oxygen required | .957E+04 lb/day |
| | Sludge produced | .656E+04 lb/day |
| | Nitrogen required | .850E+04 lb/day |
| | Phosphorous requirement | .170E+01 lb/day |
| | Sludge recycle ratio | .818E+02 percent |
| | Solids retention time | .686E+01 days |
| | Volumetric Loading | .478E+02 lb BOD/tcft |

### Quantities for Diffused Aeration System

| | |
|---|---|
| Average daily wastewater flow | .510E+01 MGD |
| Total number of tanks | 4 |
| Number of batteries | 1 |
| Actual volume per tank | .401E+05 cu ft |
| Process air requirement | .106E+05 scfm |
| Number of diffusers per tank | 221 |
| Number of swing arm headers per tank | 4 |
| Length of aeration tanks | .890E+02 feet |
| Pipe gallery width | .220E+02 feet |
| Volume of earthwork required | .966E+05 cu ft |
| Reinforced slab concrete required | .471E+05 cu ft |
| Reinforced wall concrete required | .227E+05 cu ft |
| Handrail length | .127E+04 feet |
| Operation manpower required | .283E+04 pers-hrs/year |
| Maintenance manpower required | .163E+04 pers-hrs/year |

## Typical Cost Summary

| Unit | Capital Cost $ | Amrtort Cost $/Yr. | Labor Cost $/Yr. | Labor Cost $/Yr. | Power Cost $/Yr. | Mat. Cost $/Yr. | Chem. Cost $/Yr. | O&M Cost $/Yr. |
|---|---|---|---|---|---|---|---|---|
| PRIM CLA | 225368 | 17793 | 4964 | 2231 | 361 | 2253 | 0 | 9809 |
| COMP MIX | 610868 | 45789 | 20582 | 9709 | 102200 | 14272 | 0 | 146766 |
| A SEC CL | 320779 | 25327 | 7534 | 3405 | 405 | 3207 | 0 | 14551 |
| RCY PUMP | 105329 | 12667 | 3946 | 2734 | 13614 | 1052 | 0 | 21346 |
| FLTRATI | 571005 | 50600 | 1485 | 836 | 1600 | 17369 | 0 | 21290 |
| CHLORINA | 97021 | 8412 | 7354 | 1129 | 4592 | 3550 | 9063 | 25694 |
| AIR FLOT | 237768 | 19517 | 6508 | 1558 | 7505 | 2377 | 1880 | 19831 |
| GRAV THC | 99928 | 7689 | 2607 | 1686 | 267 | 999 | 0 | 5561 |
| ANAE DIG | 562804 | 46037 | 8978 | 4733 | 3854 | 5109 | 0 | 22674 |
| FIL PRES | 893865 | 70574 | 33408 | 0 | 0 | 0 | 0 | 33408 |
| POLY F/S | 8956 | 707 | 7789 | 0 | 0 | 179 | 0 | 7968 |
| BLOWERS | 246544 | 19465 | 0 | 0 | 0 | 0 | 0 | 0 |
| SUB TOTAL | 402526 | 327982 | 105160 | 28027 | 134405 | 50372 | 10952 | 328898 |

## Historical Development of CAPDET

CAPDET stands for "Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems". It has been jointly developed over the last 10 years by the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers as a screening tool for the evaluation and ranking of wastewater treatment alternatives. The effectiveness of CAPDET as a screening tool was confirmed by a number of investigators (1,2,3). The Office of Water and Waster Management (EPA) recommended its use for facilities plan review. The agency established that the total project cost given by CAPDET were generally within 15% of the actual bid data. Similar studies (1,3) revealed that, under Canadian conditions, CAPDET provided construction cost estimates that were within 20% of actual bid data (reprints available from Hydromantis, Inc.). CAPDET is well documented. In addition to the User's Manual, a detailed Design Manual clearly defines the models used by the program for every unit operation.

## What About CAPDET-PC?

Because of its size (in excess of 25,000 lines of FORTRAN code), CAPDET was, up to now, limited to mainframe computers and required an extensive overlay structure. CAPDET-PC represents a major breakthrough in the adaptation of mainframe programs to personal computers. Major sections of the original program had to be re-written to accomodate the program on PC-based microcomputers. The result is an efficient and total implementation of CAPDET on microcomputers. CAPDET-PC consists of two independent modules: CAPDET(lg)-PC for large wastewater treatment facilities and CAPDET(sm)-PC for small systems, i.e., less than 0.5 MGD. Original CAPDET data files can be transferred to PC's and processed without any modification using CAPDET-PC.

## References


1. Pineau, M., Côté, P.L. and Villeneuve, J.P. (1985). Estimation of wastewater treatment costs: Evaluation of the CAPDET model for Canadian conditions. *Can. J. Civil Engineering*, 12(3):483-493.
2. McGhee, T.J., Mojgani, P. and Vicidomina, F. (1983). Use of EPA's CAPDET program for evaluation of wastewater treatment alternatives. *J. Water Poll. Control Fed.*, 55(1):35-43.
3. Wright, D.G., Patry, G.G., Letman, C.E. and Woods, D.R. (1988). A procedure for estimating the capital costs of Ontario wastewater treatment plants using CAPDET. *Can. J. Civil Engineering*, 15(5):799-806.

EPA

# Infiltration/Inflow

## I/I Analysis and Project Certification

I/I

APPENDIX F (Continued)

## Introduction

As part of facilities planning for municipal wastewater treatment facilities, the grantee must demonstrate that contributing sewer systems are not, and will not be, subject to excessive infiltration or inflow. This brochure informs grantees and facility planners on how to determine whether excessive I/I exists, and how to certify that excessive I/I has been sufficiently reduced through sewer rehabilitation.

"Infiltration" occurs when groundwater enters a sewer system through broken pipes, defective pipe joints, or illegal connections of foundation drains. "Inflow" is surface runoff that enters a sewer system through manhole covers, exposed broken pipe and defective pipe joints, cross connections between storm sewers and sanitary sewers, and illegal connections of roof leaders, cellar drains, yard drains, or catch basins.

Virtually every sewer system will have some infiltration or inflow. Guidelines have been developed to help determine what amount of infiltration and inflow is considered "excessive." To make this determination, infiltration and inflow must be evaluated separately as discussed below.

## Determination of Non-Excessive Infiltration

Based on Needs Survey data from 270 Standard Metropolitan Statistical Area Cities, the national average for dry weather flow is 120 gallons per capita per day (gpcd). This includes domestic wastewater flow, infiltration and nominal industrial and commercial flows. This average dry weather flow should be used as an indicator to determine the limit of non-excessive infiltration. If the average daily flow per capita (excluding major industrial and commercial flows greater than 50,000 gpd each) is less than 120 gpcd (i.e., a 7-14 day average measured during periods of seasonal high groundwater), the amount of infiltration is considered non-excessive.

The 120 gpcd flow rate guideline has been incorporated into EPA's final Construction Grant Regulations. These regulations provide that no further infiltration analysis work is required if the 120 gpcd guideline is not exceeded. If the average daily dry weather flow (DWF) exceeds 120 gpcd, the grantee may request special approval from the EPA Regional Administrator to proceed with project design without further infiltration studies. To receive such approval, the grantee must demonstrate that the increased flows due to infiltration can be cost-effectively treated, and that sufficient funding is available to pay for the local share of project construction and operating costs. In such cases, the incremental cost of treatment capacity over and above 120 gpcd is not eligible for EPA construction grant funding.

The grantee's basic options regarding determination of non-excessive infiltration are listed below:

*If Average DWF* ≤120 gpcd:*

- Grantee may proceed with project design and construction without further infiltration study.
- Grantee may investigate rehabilitation alternatives for specific sections of sewer system where excessive infiltration has been documented.

*If Average DWF* marginally exceeds 120 gpcd:*

- Grantee may request special approval from EPA Regional Administrator to proceed with the project without further study of infiltration correction alternatives.
- Grantee must demonstrate that project is cost-effective (i.e., that treating increased flows due to infiltration is less costly than sewer rehabilitation).

- Grantee must demonstrate that sufficient funds are available for the local share of project cost, including capital and operating costs.
- The treatment facility must be sized to treat the total flow including infiltration; however, the incremental cost of treatment capacity above 120 gpcd is not eligible for EPA construction grant funding.

*If Average DWF* > 120 gpcd,* and Special RA Approval is *not* granted:

- Further studies must be conducted to quantify excessive infiltration and evaluate alternative corrective measures.
- Based on results of these studies, the most cost-effective sewer rehabilitation program is selected, and the treatment plant is sized to handle the infiltration that cannot be cost-effectively removed.
- Upon approval of the proposed rehabilitation program by EPA, grantee may proceed with project design and construction. Total project cost (including sewer rehabilitation costs) is eligible for construction grant funding.

*Highest average daily flow recorded over a 7-14 period during a period of seasonal high groundwater.

**Determination of Non-Excessive Inflow**

A statistical analysis of data from Sewer System Evaluation Survey (SSES) studies representing more than 45 different sewer systems (i.e., separate sanitary sewer systems) indicated a strong correlation between inflow rate and service area population. Based on these data, the average wet weather flow (WWF) after removal of excessive inflow (i.e., that which can be cost-effectively removed) is 275 gpcd. This flow rate should be used as an indicator of non-excessive inflow.

If the average daily flow during periods of significant rainfall (i.e., any storm event that creates surface ponding and surface runoff; this can be related to a minimum rainfall amount for a particular geographic area) does not exceed 275 gpcd, the amount of inflow is considered non-excessive. This calculation should exclude major commercial and industrial flows (greater than 50,000 gpd each). If wet weather flows do not exceed 275 gpcd, the grantee may proceed with project design and construction without further study of inflow correction alternatives. However, if the treatment plant experiences hydraulic overloads during storm events, further study is required regardless of the wet weather flow (i.e., even in cases where WWF is less than 275 gpcd.)

The determination of non-excessive inflow is made as follows:

*If WWF* ≤ 275 gpcd,* and the treatment plant does not experience hydraulic overloads during storm events:

- Grantee may proceed with project design and construction without further inflow studies.
- Grantee may investigate rehabilitation alternatives for specific sections of the sewer system where excessive inflow has been documented.

*If WWF**>275 gpcd*, or the treatment plant experiences hydraulic overloads during storm events:

- Further studies must be conducted to quantify excessive inflow and evaluate alternative corrective measures.
- Based on results of these studies, the most cost-effective sewer rehabilitation program is selected, and the treatment plant is sized to handle the inflow that cannot be cost-effectively removed.
- Upon approval of the proposed rehabilitation program by EPA, the grantee may proceed with project design and construction. Total project cost (including sewer rehabilitation cost) is eligible for construction grant funding.

*Highest daily flow recorded during a storm event.

## I/I Cost-Effectiveness Analysis

Before obtaining a grant for sewer system rehabilitation, the grantee must determine the amount of infiltration and inflow that can be cost-effectively removed. This is essentially an estimate of the point at which the cost savings (i.e., reduction in transport and treatment cost less the cost of the rehabilitation program) is maximized. Generally, the planned I/I reduction (i.e., the target sought in a sewer rehabilitation project) is determined on the basis of a cost-effectiveness analysis. *Figure 1* illustrates how the planned I/I reduction target is established from cost curves developed in the cost-effectiveness analysis. A separate cost-effectiveness analysis should be done for infiltration alternatives and for inflow alternatives.

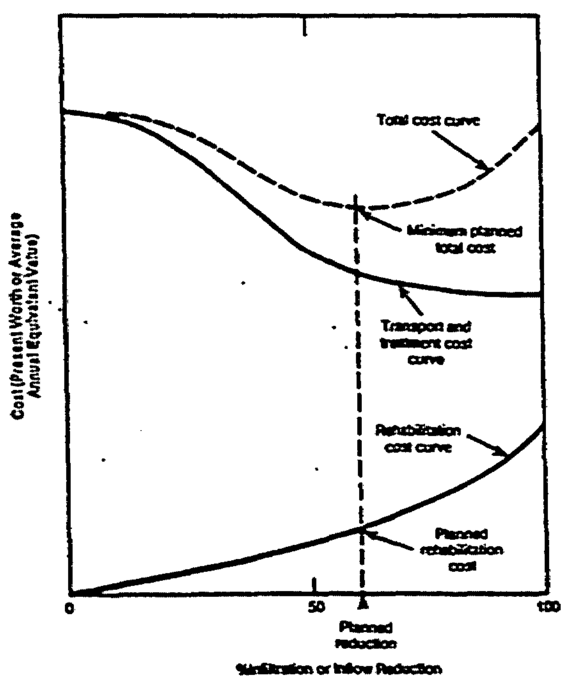



*Figure 1 Cost-Effectiveness Analysis*

**Certification of I/I Rehabilitation Performance**

At the end of the one-year performance period (i.e., one year after initiation of sewer system operation), the grantee must certify that the rehabilitation project has achieved an acceptable level of I/I reduction. Ideally, this means that the planned I/I reduction target is achieved at a cost not exceeding that projected in the cost-effectiveness analysis. However, past experience has shown that it is difficult to measure the effectiveness of an I/I rehabilitation program simply by comparing flow data before and after sewer rehabilitation.

A sewer rehabilitation project will be considered certifiable as long as the project is cost-effective (i.e. transport and treatment cost savings exceed rehabilitation costs). *Figure 2* illustrates how to determine the minimum acceptable I/I reduction using the transport and treatment cost curve from the cost-effectiveness analysis. A separate determination should be made for infiltration and for inflow, consistent with the original cost-effectiveness analysis.

The actual cost of the rehabilitation program (i.e., the "sunk cost") should include design costs and the cost of the SSES study, as well as the cost of the sewer rehabilitation itself. The acutal I/I reduction is determined by comparing post-construction flow to the flow data collected during the SSES study. The post-construction flow data should be based on plant flow records. Monitoring flows at multiple points throughout the sewer system is not recommended.

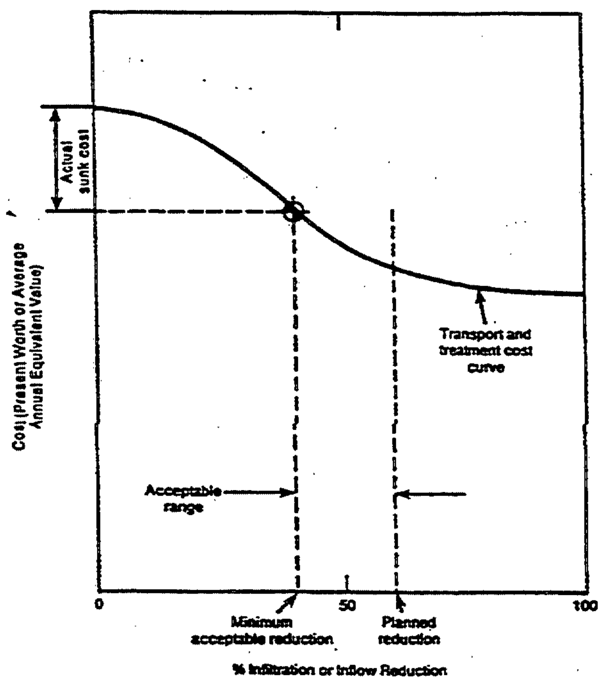



*Figure 2 Determining Acceptable Range of I/I Reduction*

If the actual I/I reduction is greater than the minimum acceptable I/I reduction derived from *Figure 2*, the rehabilitation project can be certified as meeting performance objectives. However, it should be noted the treatment plant design capacity is based on the planned I/I reduction projected in the SSES study. If the actual I/I reduction is significantly less than planned, redesign may be required to increase treatment capacity. Therefore, every effort should be made to develop realistic estimates of the amount of I/I that can be cost-effectively removed.

As an I/I project proceeds from initial planning through design and construction, certain assumptions made during the cost-effectiveness analysis may prove to be invalid. This could affect the cost-effectiveness of the project and the determination of minimum acceptable I/I reduction. For example, if the actual rehabilitation cost is greater than projected, the range of acceptable I/I reduction is reduced (*see Figure 3*). If the reduction in transport and treatment costs is not as great as expected, this will also reduce the acceptable range.

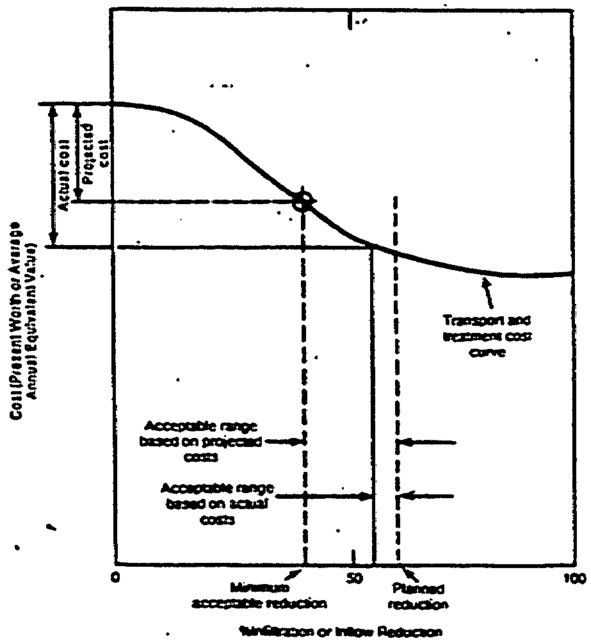



*Figure 3 Effect of Underestimating Project Costs*

Therefore, it is important to recalculate the acceptable range of I/I reduction at different stages of the project (e.g., after approval of SSES study; after completion of design and preparation of detailed cost estimates; after receipt of construction bids; and at completion of various construction phases) using updated cost estimates or actual cost data.

As the minimum acceptable I/I reduction limit approaches the planned I/I reduction target, the cost-effectiveness of the project should be reevaluated. The risk of the project not achieving the minimum acceptable I/I reduction increases as the acceptable range derived from *Figure 2* diminishes. If there is evidence that actual rehabilitation costs will be much higher than projected, it may be advisable to reassess the objectives of the rehabilitation program, and modify the scope of work accordingly.

## Summary

This brochure presents an overview on how to approach the implementation of an infiltration/inflow correction program. A schematic of the process is presented in *Figure 4*. The basic steps are as follows:

1. Determine if excessive infiltration exists using 120 gpcd guideline.

2. Determine if excessive inflow exists using 275 gpcd guideline.

3. If infiltration and inflow are non-excessive, proceed with project design based on measured flow data.

4. If either excessive infiltration or excessive inflow exists, conduct sewer system evaluation survey (SSES) study.

5. Select most cost-effective sewer rehabilitation alternative.

6. Implement sewer system rehabilitation; verify project cost-effectiveness as updated cost data become available.

7. Upon completion of project (i.e., at end of one-year performance period), certify that I/I reduction is within acceptable range.

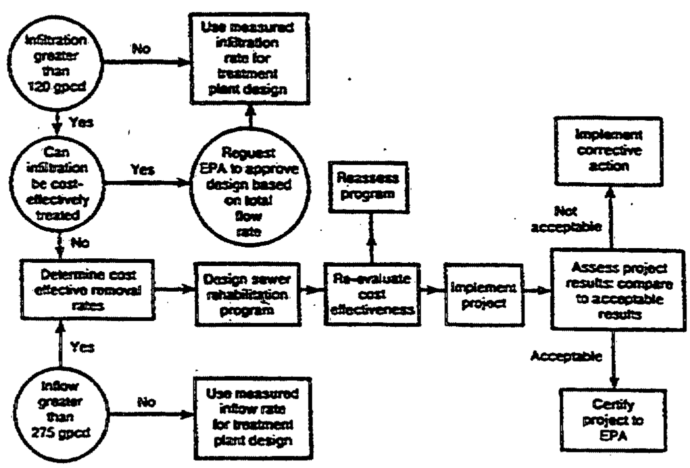



*Figure 4 I/I Project Flow Chart*

To achieve affirmative project certification, the estimates of rehabilitation cost and I/I reduction must be realistic. Underestimating project cost can invalidate the conclusions of the cost-effectiveness analysis conducted as part of the SSES study. It is important to include all cost items in the cost estimates (the cost of service line rehabilitation should be included even though it is not grant eligible).

Sewer rehabilitation programs can significantly reduce transport and treatment costs, and therefore should be given serious consideration. However, the cost-effectiveness of such projects must be carefully evaluated to assure that rehabilitation is justified. The requirements for project certification now mandate that project cost-effectiveness be confirmed at the completion of the project. Grantees and their engineers should carefully asses their I/I correction plans to be sure that project certification requirements can be satisfied.

Further guidance on this subject is available from U.S. EPA Regional Offices and delegated State agencies.

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TECHNICAL BULLETIN

# DESIGN CRITERIA FOR MECHANICAL, ELECTRIC, AND FLUID SYSTEM AND COMPONENT RELIABILITY

Supplement to Federal Guidelines for Design, Operation, and Maintenance of Waste Water Treatment Facilities

Office of Water Program Operations
U. S. Environmental Protection Agency
Washington, D. C. Z0460

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 85 cents

## FOREWORD

In response to the recent clean water legislation, this country will undertake an unprecedented building program for new and improved municipal wastewater treatment works. It is the responsibility of the EPA to ensure that the Federal funds authorized under Title II of PL 92-500 for this program will be justifiably spent. Accordingly, we must ensure that these works have been designed with a high degree of technical excellence and will operate effectively day in and day out. As a part of this effort, this Technical Bulletin provides a national standard to help ensure that unacceptable degradation of the works' effluent does not occur from time to time as a result of periodic maintenance or the malfunctioning of mechanical, electric, and fluid systems and components.

To assure a workable and effective document, we have involved all sectors of the wastewater treatment industry in the development and review of this Technical Bulletin. In this regard, I particularly wish to thank the EPA Technical Advisory Group for Municipal Waste Water Systems for their advice and counsel.

The design criteria contained in this Technical Bulletin are meant to be specific enough to have force and meaning, yet have administrative flexibility so as to permit innovation as to how the intent of the criteria will be met in each individual case. It is our intent to update and revise these criteria as experience dictates.

I am confident that through the continued efforts and cooperation of the engineering profession, the objective of improved reliability of wastewater treatment works will be achieved.

Robert L. Sansom
Assistant Administrator
for Air and Water Programs

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## DESIGN CRITERIA FOR MECHANICAL, ELECTRIC, AND FLUID SYSTEM AND COMPONENT RELIABILITY

### Purpose

The purpose of this Technical Bulletin is to amplify and supplement the Federal Guidelines for Design, Operation, and Maintenance of Wastewater Treatment Facilities with regard to establishing minimum standards of reliability for mechanical, electric, and fluid systems and components. This Technical Bulletin provides reliability design criteria for wastewater treatment works projects seeking Federal financial assistance under PL 92-500.

### Applicability of Technical Bulletin

New treatment works and additions or expansions to existing treatment works shall comply with this Technical Bulletin. Portions of existing works, for which the addition or expansion is dependent for reliable operation, shall comply with this Technical Bulletin to the degree practicable. There may be some treatment works for which fulfillment of some of the design criteria may not be necessary or appropriate. There will be other cases in which these criteria are insufficient, and additional criteria will be identified by the Regional Administrator. It is expected that additional criteria may be needed for unusual environmental conditions and for new processes. Within this context, the design criteria should be used as a reference, allowing additions or deletions as an individual case may warrant.

A basic requirement specified in these criteria is component backup. However, system reliability can also be attained through flexibility in the design and operation of systems and components.

This document does not attempt to define requirements for system flexibility.

Definitions

The following definitions apply to the terms used in this Technical Bulletin:

Component - A single piece of equipment which performs a specific function in the wastewater treatment works. In this context a component may be an entire piece of process equipment (e.g., sedimentation basin or vacuum filter) or may be a single piece of equipment (e.g., a valve or a pump).

Controlled Diversion - Diversion in a controlled manner of inadequately treated wastewater around the treatment works to navigable waters.

Design Flow - That flow used as the basis of design of a component and/or system.

Design Period - The period of time from first operation to the year at which the treatment works is expected to treat the design flow.

Effluent Limitation - Any restriction established by a State or the EPA Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean, including schedules of compliance.

Fluid System - A system within the treatment works which contains liquid or gaseous fluids. This includes the main wastewater treatment system, parts of the sludge handling and disposal system, and auxiliary systems.

Hydraulic Capacity - The maximum flow capacity of a component which does not result in flooding or overflowing.

Navigable Waters - The waters of the United States, including the territorial seas, as defined in PL 92-500.

Peak Wastewater Flow - The maximum wastewater flow expected during the design period of the treatment works.

Reliability - A measurement of the ability of a component or system to perform, its designated function without failure. In this Technical Bulletin, reliability pertains to mechanical, electric, and fluid systems and components only and includes the maintainability of those systems and components. Reliability of biological processes, operator training, process design, or structural design is not within the scope of this Technical Bulletin. The reliability aspects related to works' influent from combined sewers are not within the scope of this Technical Bulletin.

Unit Operation - An operation involving a single physical or chemical process. Examples of a unit operation are comminuting, mixing, sedimentation, aeration, and flocculation.

Vital Component - A component whose operation or function is required to prevent a controlled diversion, is required to meet effluent limitations, or is required to protect other vital components from damage.

Wastewater Treatment Works - The works that treats the wastewater, including the associated wastewater pumping or lift stations, whether or not the stations are physically a part of the works. Holding ponds or basins are considered included, whether or not the ponds or basins are physically a part of the works.

Terms Used in Specifying Criteria

The following are clarifications of terms used in specifying criteria in this Technical Bulletin:

- Shall - Used to specify criteria which are mandatory. Departure from these criteria requires a Departure Request to be submitted by the Grant Applicant and approval of the request by the Regional Administrator.
- Permissible - Used to clarify the intent of mandatory criteria by giving examples of designs which are in conformance with the criteria.
- Consideration and Where Practicable - Used to specify criteria which shall be considered by the Grant Applicant, but which are not mandatory.

Reliability Classification

This Technical Bulletin establishes minimum standards of reliability for three classes of wastewater treatment works. Unless identified as applying to a particular class, all criteria contained in this document apply equally to all three classes. The reliability classification shall be selected and justified by the Grant Applicant, subject to the approval of the Regional Administrator, and shall be based on the consequences of degradation of the effluent quality on the receiving navigable waters. This document does not specify requirements for classifying works; however, suggested guidelines are:

Reliability Class I

Works which discharge into navigable waters that could be permanently or unacceptably damaged by effluent which was degraded in quality for only a few hours. Examples of Reliability Class I works might be those discharging near drinking water reservoirs, into shellfish waters, or in close proximity to areas used for water contact sports.

Reliability Class II

Works which discharge into navigable waters that would not be permanently or unacceptably damaged by short-term effluent quality degradations, but could be damaged by continued (on the order of several days) effluent quality degradation. An example of a Reliability Class II works might be one which discharges into recreational waters.

Reliability Class III

Works not otherwise classified as Reliability Class I or Class II.

Note: Pumping stations associated with, but physically removed from, the actual treatment works could have a different classification from the works itself.

## 100. WORKS DESIGN CRITERIA

## 100. WORKS DESIGN CRITERIA

### 110. WORKS LOCATION

The potential for damage or interruption of operation due to flooding shall be considered when siting the treatment works. The treatment works' structures and electrical and mechanical equipment shall be protected from physical damage by the maximum expected one hundred (100) year flood. The treatment works shall remain fully operational during the twenty-five (25) year flood, if practicable; lesser flood levels may be permitted dependent on local situations, but in no case shall less than a ten (10) year flood be used. Works located in coastal areas subject to flooding by wave action shall be similarly protected from the maximum expected twenty-five (25) and one hundred (100) year wave actions.

Existing works being expanded, modified, upgraded or rehabilitated shall comply with these criteria to the degree practicable.

The flood and wave action elevations used to implement these criteria shall be determined and justified by the Grant Applicant, using available data sources where appropriate. Elevations for a specific location may be available from local or state studies as well as studies by the following Federal organizations: U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Soil Conservation Service, National Oceanic and Atmospheric Administration, and Tennessee Valley Authority.

The works shall be accessible in all normal seasonal conditions, including the expected annual floods.

## 120. PROVISIONS FOR WORKS EXPANSION AND/OR UPGRADING

All new works and expansions to existing works shall be designed for further expansion except where circumstances preclude the probability of expansion. During a works' upgrading or expansion the interruption of normal operation shall be minimized and shall be subject to the approval of the Regional Administrator.

## 130. PIPING REQUIREMENTS

### 131. Pipes Subject to Clogging

#### 131.1 Provisions for Flushing of Pipes

The works shall have provisions for flushing with water and/or air all scum lines, sludge lines, lime feed and lime sludge lines, and all other lines which are subject to clogging. The design shall be such that flushing can be accomplished without causing violation of effluent limitations or without cross-connections to the potable water system.

#### 131.2 Provisions for Mechanical Cleaning of Pipes

All piping subject to accumulation of solids over a long period of time shall have sufficient connections and shall be arranged in a manner to facilitate mechanical cleaning. This may include the main wastewater treatment process piping, service water system piping, and sludge process piping. Special attention shall be paid to piping containing material which has a tendency to plug, such as scum lines, drain lines, and lime sludge lines. System design shall be such that the mechanical cleaning can be accomplished without violation of effluent limitations.

132. Provisions for Draining Pipes

Where practicable, all piping shall be sloped and/or have drains (drain plug or valve) at the low points to permit complete draining. Piping shall be installed with no isolated pockets which cannot be drained.

133. Maintenance and Repair of Feed Lines

Lines feeding chemicals or process air to basins, wetwells, and tanks shall be designed to enable repair or replacement without drainage of the basins, wetwells or tanks.

140. COMPONENT MAINTENANCE AND REPAIR REQUIREMENTS

141. Component Repair

Every vital mechanical component (mechanical components include such items as pumps, bar screens, instrumentation and valves, but not piping, tanks, basins, channels, or wells) in the works shall be designed to enable repair or replacement without violating the effluent limitations or causing a controlled diversion. To comply with this requirement, it is permissible to use the collection system storage capacity or holding basins and to perform maintenance during the low influent flow periods. This requirement applies to shutoff and isolation valves. Provisions shall be made in the initial works design to permit repair and replacement of these types of valves.

Example: This criterion applies to the isolation valves of main wastewater pumps. The following are examples of ways these valves could be maintained. Pump suction isolation valves can be maintained if the works has a two compartment main pump wetwell and if the works can continue operation (during the diurnal low flow period, for example) with one part of the wetwell isolated. Pump discharge isolation valves connected to a pressurized outlet header can be maintained if the collection system storage capacity is sufficiently large to permit all main wastewater pumps to be stopped (collection system storage capacity is used) while the valve in question is removed and blind flanges installed.

142. Component Access Space

Adequate access and removal space shall be provided around all components to permit easy maintenance and/or removal and replacement without interfering with the operation of other equipment. Components located inside buildings or other structures shall be removable without affecting the structural integrity of the building or creating a safety hazard. Normal disassembly of the component is permissible for removal and replacement. This criterion is not intended to be applicable to the removal or replacement of large tanks, basins, channels, or wells.

Note: This criterion requires that consideration be given to the sizing of doors, stairways, hallways, hatches, elevators and other access ways in the initial works design. It also requires that special thought be given to the physical layout of piping systems and components in the initial design, especially to components located above and below the ground level of buildings and to unusually large components. The complete path of removal from in-plant location, through hatches, doors and passageways, to a truck or other service vehicle should be checked and defined for each component.

143. Component Handling

The works shall have lifting and handling equipment available to aid in the maintenance and replacement of all components. In addition, the placement of structures and other devices, such as pad-eyes and hooks, to aid component handling shall be considered in the initial design. This is particularly important for large and/or heavy components which require special handling and lifting equipment. Means shall be provided for removal of components located above and below the ground level of buildings and other structures. This criterion is not intended to be applicable to the removal or replacement of large tanks, basins, channels, or wells.

144. Essential Services

Essential services, such as water, compressed air, and electricity, shall be made available throughout the works where required for cleaning, maintenance, and repair work. To facilitate cleaning wetwells, tanks, basins and beds, water (supplied from a non-potable water system or the works' effluent) shall be supplied at these points by means of a pressurized water system with hydrants or hose bibs having minimum outlet diameters of one inch.

150. ISOLATION OF HAZARDOUS EQUIPMENT

Equipment whose failure could be hazardous to personnel or to other equipment shall have means for isolation, such as shutoff valves, or shutoff switches and controls located away from, the equipment to permit safe shutdown during emergency conditions.

200. SYSTEM DESIGN CRITERIA

## 200. SYSTEM DESIGN CRITERIA

### 210. WASTEWATER TREATMENT SYSTEM

The wastewater treatment system includes all components from and including the bar screens and wastewater pumps to and including the works outfall.

### 211. System Requirements

The wastewater treatment system shall be designed to include the following:

#### 211.1 Trash Removal or Comminution

The system shall contain components to remove and/or comminute trash and all other large solids contained in the wastewater.

#### 211.2 Grit Removal

The system shall contain components to remove grit and other heavy inorganic solids from the wastewater. This requirement shall not apply to types of treatment works which do not pump or dewater sludge, such as waste stabilization ponds.

#### 211.3 Provisions for Removal of Settled Solids

All components, channels, pump wells and piping prior to the degritting facility or primary sedimentation basin shall be accessible for cleaning out settled solids. The provisions shall enable manual or mechanical cleaning of equipment on a periodic basis without causing a controlled diversion or causing violation of effluent limitations.

211.4 Treatment Works Controlled Diversion

Wastewater treatment works shall be provided with a controlled diversion channel or pipe sized to handle peak wastewater flow. Actuation of the controlled diversion shall be by use of a gravity overflow. The overflow elevation shall be such that the maximum feasible storage capacity of the wastewater collection system will be utilized before the controlled diversion will be initiated. The controlled diversion flow shall be screened to remove large solids unless the wastewater flow has been previously screened. The actuation of a controlled diversion shall be alarmed and annunciated (see Paragraph 243 of this Technical Bulletin), and the flow shall be measured and recorded.

All Reliability Class I wastewater treatment works shall have a holding basin to augment the storage capacity of the collection system. The controlled diversion system and the holding basin shall be designed to permit the wastewater retained by the holding basin to be fully treated in the wastewater treatment works. The capacity of the holding basin shall be sized by the Grant Applicant based on the constraints and conditions applicable to that specific treatment works.

211.5 Unit Operation Bypassing

The design of the wastewater treatment system shall include provisions for bypassing around each unit operation, except as follows. The term unit operation does not apply to pumps in the context of this criterion. Unit operations with two or more units and involving open basins, such as sedimentation basins, aeration basins, disinfectant contact basins, shall not be required to have provisions for bypassing if the peak wastewater flow can be handled hydraulically with the largest flow capacity unit out of service. All other unit operations with three or more units shall not be required to have provisions for bypassing if the peak wastewater flow can be handled hydraulically with the two largest flow capacity units out of service.

The comminution facility shall be provided with a means for bypassing regardless of the number and flow capacity of the comminutors.

The bypassing system for each unit operation shall be designed to provide control of the diverted flow such that only that portion of the flow in excess of the hydraulic capacity of the units in service need be bypassed. With the exception of the comminution facility, which shall have a gravity overflow, the actuation of all other unit operation bypasses shall require manual action by operating personnel. All power actuated bypass valve operators shall be designed to enable actuation with loss of power and shall be designed so that the valve will fail as is, upon failure of the power operator. A disinfection facility having a bypass shall contain emergency provisions for disinfection of the bypassed flow.

212. Component Backup Requirements

Requirements for backup components for the main wastewater treatment system are specified below for Reliability Class 1, II, and III works.

Except as modified below, unit operations in the main wastewater treatment system shall be designed such that, with the largest flow capacity unit out of service, the hydraulic capacity (not necessarily the design-rated capacity) of the remaining units shall be sufficient to handle the peak wastewater flow. There shall be system flexibility to enable the wastewater flow to any unit out of service to be distributed to the remaining units in service.

Equalization basins or tanks shall not be considered a substitute for component backup requirements.

212.1 Reliability Class I

For components included in the design of Reliability Class I works, the following backup requirements apply.

212.1.1 Mechanically-Cleaned Bar Screens or Equivalent Devices

A backup bar screen shall be provided. It is permissible for the backup bar screen to be designed for manual cleaning only. Works with only two bar screens shall have at least one bar screen designed to permit manual cleaning.

212.1.2 Pumps

A backup pump shall be provided for each set of pumps which performs the same function. The capacity of the pumps shall be such that with any one pump out of service, the remaining pumps will have capacity to handle the peak flow. It is permissible for one pump to serve as backup to more than one set of pumps.

212.1.3 Comminution

If comminution of the total wastewater flow is provided, then an overflow bypass with an installed manually- or mechanically-cleaned bar screen shall be provided. The hydraulic capacity of the comminutor overflow bypass shall be sufficient to pass the peak flow with all comminution units out of service.

212.1.4 Primary Sedimentation Basins

There shall be a sufficient number of units of a size, such that with the largest flow capacity unit out of service, the remaining units shall have a design flow capacity of at least 50 percent of the total design flow to that unit operation.

212.1.5 Final and Chemical Sedimentation Basins, Trickling Filters, Filters and Activated Carbon Columns

There shall be a sufficient number of units of a size, such that with the largest flow capacity unit out of service, the remaining units shall have a design flow capacity of at least 75 percent of the total design flow to that unit operation.

212.1.6 Activated Sludge Process Components

212.1.6.1 Aeration Basin

A backup basin shall not be required; however, at least two equal volume basins shall be provided. (For the purpose of this criterion, the two zones of a contact stabilization process are considered as only one basin.)

212.1.6.2 Aeration Blowers or Mechanical Aerators

There shall be a sufficient number of blowers or mechanical aerators to enable the design oxygen transfer to be maintained with the largest capacity unit out of service. It is permissible for the backup unit to be an uninstalled unit, provided that the installed unit can be easily removed and replaced. However, at least two units shall be installed.

212.1.6.3 Air Diffusers

The air diffusion system for each aeration basin shall be designed such that the largest section of diffusers can be isolated without measurably impairing the oxygen transfer capability of the system.

212.1.7 Chemical Flash Mixer

At least two mixing basins or a backup means for adding and mixing chemicals, separate from the basin, shall be provided. If only one basin is provided, at least two mixing devices and a bypass around the basin shall be provided. It is permissible for one of the mixing devices to be uninstalled, provided that the installed unit can be easily removed and replaced.

212.1.8 Flocculation Basins

At least two flocculation basins shall be provided.

212.1.9 Disinfectant Contact Basins

There shall be a sufficient number of units of a size, such that with the largest flow capacity unit out of service, the remaining units shall have a design flow capacity of at least 50 percent of the total design flow to that unit operation.

212.2 Reliability Class II

The Reliability Class I requirements shall apply except as modified below.

212.2.1 Primary and Final Sedimentation Basins and Trickling Filters

There shall be a sufficient number of units of a size such that, with the largest flow capacity unit out of service, the remaining units shall have a design flow capacity of at least 50 percent of the design basis flow to that unit operation.

212.2.2 Components Not Requiring Backup

Requirements for backup components in the wastewater treatment system shall not be mandatory for components which are used to provide treatment in excess of typical biological (i. e. , activated sludge or trickling filter), or equivalent physical/chemical treatment, and disinfection. This may include such components as:

Chemical Flash Mixer
Flocculation Basin
Chemical Sedimentation Basin
Filter
Activated Carbon Column

212.3 Reliability Class III

The Reliability Class I requirements shall apply except as modified below.

212.3.1 Primary and Final Sedimentation Basins

There shall be at least two sedimentation basins.

212.3.2 Activated Sludge Process Components

212.3.2.1 Aeration Basin

A single basin is permissible.

212.3.2.2 Aeration Blowers of Mechanical Aerators

There shall be at least two blowers or mechanical aerators available for service. It is permissible for one of the units to be uninstalled, provided that the installed unit can be easily removed and replaced.

212.3.2.2 Air Diffusers

The Reliability Class I requirements shall apply.

212.2.2 Components Not Requiring Backup

Requirements for backup components in the wastewater treatment system shall not be mandatory for components which are used to provide treatment in excess of primary sedimentation and disinfection, except as modified above. This may include such components as:

Trickling Filter
Chemical Flash Mixer
Flocculation Basin
Chemical Sedimentation Basin
Filter
Activated Carbon Column

213. Component Design Features and Maintenance Requirements

213.1 Provisions for Isolating Components

Each component shall have provisions to enable it to be isolated from the flow stream to permit maintenance and repair of the component without interruption of the works' operation. Where practicable, simple shutoff devices, such as stop logs and slide gates, shall be used.

213.1.1 Main Wastewater System Pump Isolation

The use of in-line valves to isolate the main wastewater pumps shall be minimized. It is permissible to place shutoff valves on the suction and discharge lines of each pump. However, in such a case, alternate means shall be provided for stopping flow through the pump suction or discharge lines to permit maintenance on the valves.

Example: Pump discharge isolation and check valves are not needed if the pumps have a free discharge into an open channel rather than discharging into a pressurized discharge header. Pump suction isolation valves can be maintained if the plant has a two compartment wetwell design and if the plant can continue operation (during the diurnal low-flow period, for example) with one part of the wetwell isolated.

213.2 Component Protection

213.2.1 Protection from Overload

Components or parts of components subject to clogging, blockage, binding or other overloads shall be protected from damage due to the overload. Examples of components requiring protection include the rake mechanism of bar screens, comminuting equipment, the grit-removal mechanism in degritting facilities, and sludge and scum arms of sedimentation basins.

213.2.2 Protection from Freezing

Components or parts of components which are wetted and subject to freezing shall be designed to ensure that the components will be operable during winter climatic conditions anticipated at the works. Examples of components or parts of components which may require protection include bar screens, comminuting equipment, the grit-removal mechanism in degritting facilities, mechanical aerators and the scum arm of sedimentation basins.

213.2.3 Protection from Up-Lift Due to Ground Water

In-ground tanks and basins shall be protected from up-lift due to ground water. If sufficient ballast is not provided in each tank or basin, other means for ground water relief shall be provided.

213.3 Slide Gates

Consideration shall be given to providing mechanical operators or other mechanical assistance for slide gates which, due to their size or infrequent use, may not be easily removable by manual means alone.

213.4 Bar Screens or Equivalent Devices

213.4.1 Provisions for Manual Cleaning

Manually-cleaned bar screens or mechanically-cleaned bar screens which can be Manually cleaned shall have accessible platforms above the bar screen from which the operator can rake screenings easily and safely when the screens are in operation.

213.4.2 Provisions for Lifting and Handling Equipment

The design of the equipment and the works shall contain provisions for easily and safely lifting and handling all parts of a mechanically-cleaned bar screen. Special attention shall be given to the proper location of eyes, rails and hooks located above the equipment to facilitate lifting and handling.

213.5 Comminution Equipment and Degritting Facility

All mechanical components shall be easily removable for maintenance and repair.

213.6 Sedimentation Basins

The main drive mechanism and reducing gears shall be maintainable and repairable without draining the basin. The number of other operating parts which require draining the basin for repair and maintenance shall be minimized.

213.7 Aeration Equipment

213.7.1 Component Maintenance

Mechanical aerators or air diffusers shall be easily removable from the aeration tank to permit maintenance and repair without interrupting operation of the aeration tank or inhibiting operation of the other aeration equipment.

213.7.2 Filtration of Air

If air is supplied to fine bubble diffusers, air filters shall be provided in numbers, arrangement and capacities to furnish at all times an air supply sufficiently free from dust to minimize clogging of the diffusers.

213.8 Chemical Mixing Basin and Flocculation Basin

213.8.1 Component Maintenance

The mixing and flocculating devices shall be completely removable from the basin to allow maintenance and repair of the device, preferably without draining the basin.

213.8.2 Chemical Feed Line Cleaning

Chemical feed lines shall be designed to permit their being cleaned or replaced without draining the mixing basin or interrupting the normal flow through the basin.

213.8.3 Provisions for Isolation

Isolation valves or gates for the mixing or flocculation basin shall be designed to minimize the problems associated with operation of these devices after long periods of idleness and the resulting buildup of chemical deposits. Access and capability for cleaning debris and deposits which interfere with valve or gate closure shall be provided.

213.9 Filters and Activated Carbon Columns

There shall be easy access to the interior of carbon columns and filters to permit maintenance and repair of internal mechanisms.

220. SLUDGE HANDLING AND DISPOSAL SYSTEM

This system includes all components and unit processes from the sludge pumps servicing the sedimentation basins to the final disposal of waste products, including ancillary components. Sludge disposal includes the special handling and treatment of sludge bypassing a normal stage of treatment. In some treatment works the system may also include processes such as recalcination of lime or regeneration of activated carbon.

221. System Requirements

The sludge handling and disposal system shall be designed to include the following:

221.1 Alternate Methods of Sludge Disposal and/or Treatment

Alternate methods of sludge disposal and/or treatment shall be provided for each sludge treatment unit operation without installed backup capability.

221.2 Provisions for Preventing Contamination of Treated Wastewater

All connections (sludge, scum, filtrate, supernatant, or other contaminated water flows), direct or indirect, from the sludge handling system to the wastewater treatment system shall be at a point in the wastewater treatment system that will ensure adequate treatment.

222. Component Backup Requirements

For components included in the design of the sludge handling and disposal system of Reliability Class I, II, or III works the following backup requirements apply.

222.1 Sludge Holding Tanks

Holding tanks are permissible as an alternative to component or system backup capability for components downstream of the tank, provided the following requirements are met. The volume of the holding tank shall be based on the expected time necessary to perform maintenance and repair of the component in question. If a holding tank is used as an alternative to backup capability in a sludge treatment system which is designed for continuous operation, the excess capacity in all components downstream of the holding tanks shall be provided to enable processing the sludge which was retained together with the normal sludge flow.

222.2 Pumps

A backup pump shall be provided for each set of pumps which performs the same function. The capacity of the pumps shall be such that with any one pump out of service, the remaining pumps will have capacity to handle the peak flow, It is permissible for one pump to serve as backup to more than one set of pumps. It is also permissible for the backup pump to be uninstalled, provided that the installed pump can be easily removed and replaced. However, at least two pumps shall be installed.

222.3 Aerobic Sludge Digestion

222.3.1 Digestion Tanks

At least two digestion tanks shall be provided. At least two of the digestion tanks provided shall be designed to permit processing all types of sludges normally digested.

222.3.2 Mix Equipment

If mixing is required as part of the digestion process, then each tank requiring mixing shall have sufficient mixing equipment or flexibility in system design to ensure that the total capability for mixing is not lost when any one piece of mechanical mixing equipment is taken out of service. It is permissible for the backup equipment not to be installed (e.g., a spare uninstalled digester gas compressor is permissible if gas mixing is used); not be normally used for sludge mixing (e.g., sedimentation basin sludge pumps may be used); or not be full capacity (e.g., two 50 percent-capacity recirculation pumps would comply with this requirement).

222.4 Aerobic Sludge Digestion

222.4.1 Aeration Basin

A backup basin is not required.

222.4.2 Aeration Blowers or Mechanical Aerators

At least two blowers or mechanical aerators shall be provided. It is permissible for less than design oxygen transfer capability to be provided with one unit out of service. It is permissible for the backup unit to be an uninstalled unit, provided that the installed unit can be easily removed and replaced.

222.4.3 Air Diffusers

The air diffusion system for each aeration basin shall be designed such that the largest section of diffusers can be isolated without measurably impairing the oxygen transfer capability of the system.

222.5 Vacuum Filters

There shall be a sufficient number of vacuum filters to enable the design sludge flow to be dewatered with the largest capacity vacuum filter out of service.

Note: Since the design basis of sludge dewatering equipment is often not continuous operation, this criterion does not necessarily require additional vacuum filter capacity if the installed equipment is operated on less than a 24 hour-per-day basis and if the normal operating hours can be extended on the remaining units to make up the capacity lost in the unit out of service.

222.5.1 Auxiliary Equipment

Each vacuum filter shall be serviced by two vacuum pumps and two filtrate pumps. It is permissible for the backup to the normal vacuum or filtrate pump to be an uninstalled unit, provided that the installed unit can be easily removed and replaced; or to be a crossconnect line to the appropriate system of another vacuum filter.

222.6 Centrifuges

There shall be a sufficient number of centrifuges to enable the design sludge flow to be dewatered with the largest capacity centrifuge out of service. It is permissible for the backup unit to be an uninstalled unit, provided that the installed unit can be easily removed and replaced.

Note: Since the design basis of sludge dewatering equipment is often not continuous operation, this criterion does not necessarily require additional equipment if the installed equipment is operated on less than a 24 hour-per-day basis and if the normal operating hours can be extended on the remaining units to make up the capacity lost in the unit out of service.

222.7 Incinerators

A backup incinerator is not required (see Paragraph 222.1.1 for requirements for alternate sludge disposal capability). Auxiliary incinerator equipment whose failure during incinerator operation could result in damage to the incinerator shall be provided with backups (e.g., failure of a center shaft cooling fan could result in damage to the center shaft of a multi-hearth incinerator). In such cases, automatic actuation of the backup auxiliary equipment shall be provided.

223. Component Design Features and Maintenance Requirements

223.1 Provisions for Isolating Components

Each component shall have provisions to enable it to be isolated from the flow stream to permit maintenance and repair of the component without interruption of the works operation. Where practicable, simple shutoff devices, such as stop logs and slide gates, shall be used.

223.2 Component Protection

223.2.1 Protection from Overload

Components or parts of components subject to clogging, blockage, binding or other overloads shall be protected from damage due to the overload.

223.2.2 Protection from Freezing

Components or parts of components which are wetted and subject to freezing shall be designed to ensure that components will be operable during winter climatic conditions anticipated at the works.

223.2.3 Protection from Up-Lift Due to Ground Water

In-ground tanks and basins shall be protected from up-lift due to ground water. If sufficient ballast is not provided in each tank or basin, other means for ground water relief shall be provided.

223.3 Slide Gates

Consideration shall be given to providing mechanical operators or other mechanical assistance for slide gates which, due to their size or infrequent use, may not be easily removable by manual means alone.

223.4 Aeration Equipment

223.4.1 Component Maintenance

Mechanical aerators or air diffusers shall be easily removable from the aeration tank to permit maintenance and repair without interrupting operation of the aeration tank or inhibiting operation of the other aeration equipment.

223.4.2 Filtration of Air

If air is supplied to fine bubble diffusers, air filters shall be provided in numbers, arrangement and capacities to furnish at all times an air supply sufficiently free from dust to minimize clogging of the diffusers.

223.5 Anaerobic Sludge Digester

At least three access manholes shall be provided in the top of the tank. One opening shall be large enough to permit the use of mechanical equipment to remove grit and sand. A separate side wall manhole shall also be provided.

223.6 Incinerators

There shall be easy access to the interior of incinerators to permit maintenance and repair of internal mechanisms. Multi-hearth incinerators shall have a manhole on each hearth level.

230. ELECTRIC POWER SYSTEM

The following criteria shall apply only to those portions of the system supplying power to vital components.

231. Power Sources

Two separate and independent sources of electric power shall be provided to the works from either two separate utility substations or from a single substation and a works based generator. If available from the electric utility, at least one of the works' power sources shall be a preferred source (i.e., a utility source which is one of the last to lose power from the utility grid due to loss of power generating capacity). In geographical areas where it is projected that sometime during the design period of the works, the electric utility may reduce the rated line voltage (i.e., "brown out") during peak utility system load demands, a works based generator shall be provided as an alternate power source, where practicable. As a minimum, the capacity of the backup power source for each class of treatment works shall be:

| | |
|---|---|
| Reliability Class I | Sufficient to operate all vital components, during peak wastewater flow conditions, together with critical lighting and ventilation. |
| Reliability Class II | Same as Reliability Class I, except that vital components used to support the secondary processes (i.e., mechanical aerators or aeration basin air compressors) need not be included as long as treatment -equivalent to sedimentation and disinfection is provided. |
| Reliability Class III | Sufficient to operate the screening or comminution facilities, the main wastewater pumps, the primary sedimentation basins, and the disinfection facility during peak wastewater flow condition, together with critical lighting and ventilation. |

Note: This requirement concerning rated capacity of electric power sources is not intended to prohibit other forms of emergency power, such as diesel driven main wastewater pumps.

232. Power Distribution External to the Works

The independent sources of power shall be distributed to the works' transformers in a way to minimize common mode failures from affecting both sources.

Example: The two sets of distribution lines should not be located in the same conduit or supported from the same utility pole. The two sets of overhead distribution lines, if used, should not cross nor be located in an area where a single plausible occurrence (e.g., fallen tree) could disrupt both lines. Devices should be used to protect the system from lightning.

233. Transformers

Each utility source of power to the works shall be transformed to usable voltage with a separate transformer. The transformers shall be protected from common mode failure by physical separation or other means.

234. Power Distribution Within the Works

234.1 Service to Motor Control Centers

The internal power distribution system shall be designed such that no single fault or loss of a power source will result in disruption (i.e., extended, not momentary of electric service to more than one motor control center associated with the Reliability Class I, II, or III vital components requiring backup power per Paragraph 231, above.

234.2 Division of Loads at Motor Control Centers

Vital components of the same type and serving the same function shall be divided as equally as possible between at least two motor control centers. Nonvital components shall be divided in a similar manner, where practicable.

234.3 Power Transfer

Where power feeder or branch circuits can be transferred from one power source to another, a mechanical or electrical safety device shall be provided to assure that the two power sources cannot be cross-connected, if unsynchronized. Automatic transfer shall be provided in those cases when the time delay required to manually transfer power could result in a failure to meet effluent limitations, a failure to process peak influent flow, or cause damage to equipment. Where automatic pump control is used, the control panel power source and pump power source shall be similarly transferred. The actuation of an automatic transfer switch shall be alarmed and annunciated.

Example: An example for feeder distribution and bus transfer which meets these criteria is shown in Figure 1. The two power sources from utility substations are connected to the motor control centers through circuit breakers. A circuit breaker is provided to crossconnect the two motor control centers in the event one of the two normally energized power feeders fail. Additional backup capability has been achieved for the main pump by connecting one of the three pumps to the motor control center cross-connect. This assures that two out of three pumps will be available in the event of a panel fire or panel bus short circuit.

235. Breaker Settings or Fuse Ratings

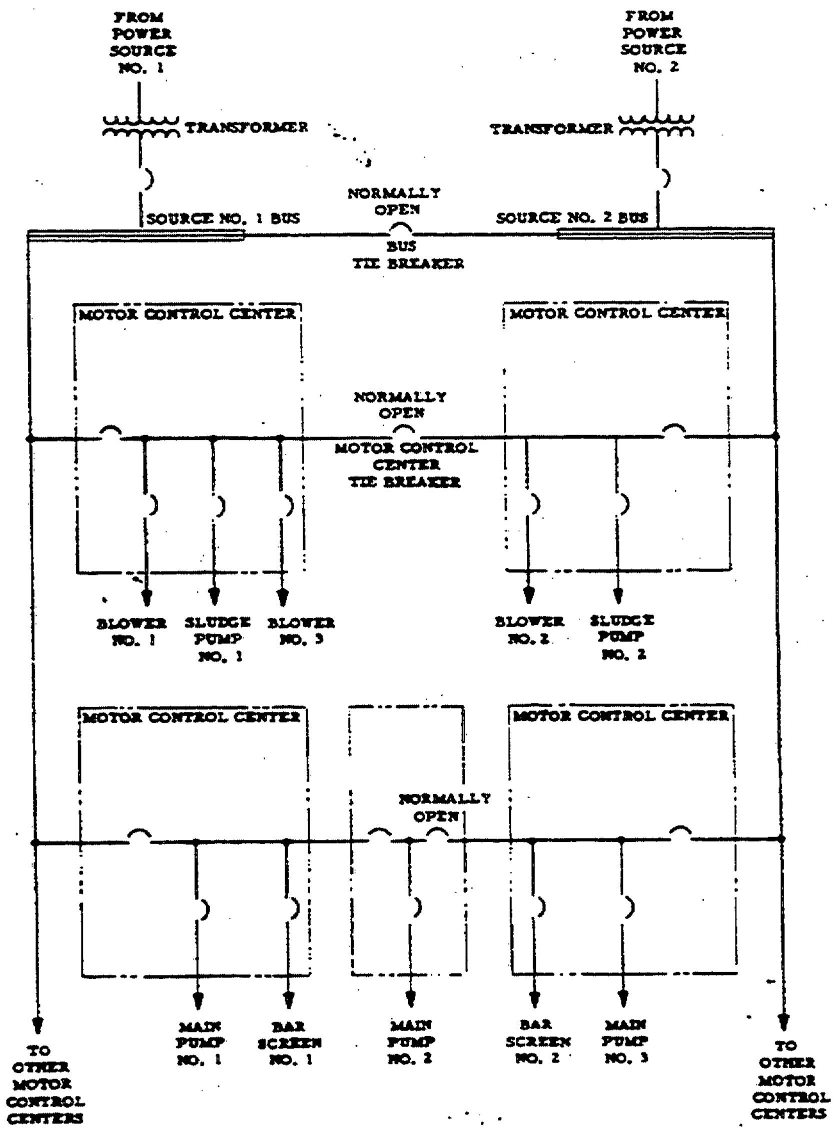
Breaker settings or fuse ratings shall be coordinated to effect sequential tripping such that the breaker or fuse nearest the fault will clear the fault prior to activation of other breakers or fuses to the degree practicable.

236. Equipment Type and Location

Failures resulting from plausible causes, such as fire or flooding, shall be minimized by equipment design and location. The following requirements apply:

**FEEDER DISTRIBUTION AND POWER TRANSFER**

FIGURE 1



236.1 Switchgear Location

Electric switchgear and motor control centers shall be protected from sprays or moisture from liquid processing equipment and from breaks in liquid handling piping, Where practicable, the electric equipment shall be located in a separate room from the liquid processing equipment. Liquid handling piping shall not be run through this room. The electric switchgear and motor control centers shall be located above ground and above the one hundred (100) year flood (or wave action) elevation.

236.2 Conductor Insulation

Wires in underground conduits or in conduits that can be flooded shall have moisture resistant insulation as identified in the National Electric Code.

236.3 Motor Protection from Moisture

All outdoor motors shall be adequately protected from the weather. Water-proof, totally enclosed or weather-protected, open motor enclosures shall be used for exposed outdoor motors. Motors located indoors and near liquid handling piping or equipment shall be, at least, splash-proof design. Consideration shall be given to providing heaters in motors located outdoors or in areas where condensation may occur. The following criteria shall apply- to motors (and their local controls) associated with vital components. All outdoor motors, all large indoor motors (i.e., those not readily available as stock items from motor suppliers), and, where practicable, all other indoor motors shall be located at an elevation to preclude flooding from the one hundred (100) year flood (or wave action or from clogged floor drains. Indoor motors located at or below the one hundred year flood (or wave action) elevation shall be housed in a room or building which is protected from flooding during the one hundred year flood (or wave action). The building protection shall include measures such as no openings (e.g., doors, windows, hatches) to the outside below the flood elevation and a drain sump pumped to an elevation above the flood elevation.

236.4 Explosion Proof Equipment

Explosion proof motors, conduit systems, switches and other electrical equipment shall be used in areas where flammable liquid, gas or dust is likely to be present.

236.5 Routing of Cabling

To avoid a common mode failure, conductors to components which perform the same function in parallel shall not be routed in the same conduit or cable tray. Conduits housing such cables shall not be routed in the same underground conduit bank unless the conduits are protected from common mode failures (such as by encasing the conduit bank in a protective layer of concrete).

236.6 Motor Protection

Three phase motors and their starters shall be protected from electric overload and short circuits on all three phases. Large motors shall have a low voltage protection device which on the reduction or failure of voltage will cause and maintain the interruption of power to that motor. Consideration shall be given to the installation of temperature detectors in the stator and bearings of large motors in order to give an indication of overheating problems.

237. Provisions for Equipment Testing

Provisions shall be included in the design of equipment requiring periodic testing, to enable the tests to be accomplished while maintaining electric power to all vital components. This requires being able to conduct tests, such as actuating and resetting automatic transfer switches, and starting and loading emergency generating equipment.

238. Maintenance

The electric distribution system and equipment shall be designed to permit inspection and maintenance of individual items without causing a controlled diversion or causing violation of the effluent limitations.

239. Emergency Power Generator Starting

The means for starting a works based emergency power generator shall be completely independent of the normal electric power source. Air starting systems shall have an accumulator tank(s) with a volume sufficient to furnish air for starting the generator engine a minimum of three (3) times without recharging. Batteries used for starting shall have a sufficient charge to permit starting the generator engine a minimum of three (3) times without recharging. The starting system shall be appropriately alarmed and instrumented to indicate loss of readiness (e.g., loss of charge on batteries, loss of pressure in air accumulators, etc.).

240. INSTRUMENTATION AND CONTROL SYSTEMS

These criteria cover the requirements for the instrumentation and control systems:

241. Automatic Control

Automatic control systems whose failure could result in a controlled diversion or a violation of the effluent limitations shall be provided with a manual override. Those automatic controls shall have alarms and annunciators to indicate malfunctions which require use of the manual override. The means for detecting the malfunction shall be independent of the automatic control system, such that no single failure will result in disabling both the automatic controls and the alarm and annunciator.

242. Instrumentation

Instrumentation whose failure could result in a controlled diversion or a violation of the effluent limitations shall be provided with an installed backup sensor and readout. The backup equipment may be of a different type and located at a different point, provided that the same function is performed. No single failure shall result in disabling both sets of parallel instrumentation.

243. Alarms and Annunciators

Alarms and annunciators shall be provided to monitor the condition of equipment whose failure could result in a controlled diversion or a violation of the effluent limitations. Alarms and annunciators shall also be provided to monitor conditions which could result in damage to vital equipment or hazards to personnel. The alarms shall sound in areas normally manned and also in areas near the equipment. Treatment works not continuously manned shall have the alarm signals transmitted to a point (e.g., fire station, police station, etc. ) which is continuously manned. The combination of alarms and annunciators shall be such that each announced condition is uniquely identified. Test circuits shall be provided to enable the alarms and I annunciators to be tested and verified to be in working order.

244. Alignment and Calibration of Equipment

Vital instrumentation and control equipment shall be designed to permit alignment and calibration without requiring a controlled diversion or a violation of the effluent limitations.

250. AUXILIARY SYSTEMS

The auxiliary systems include typical systems such as:

- Drain system, for
  - Components
  - Systems
  - Treatment works
- Compressed air system, for
  - Pneumatic controls
  - Pneumatic valve operators
  - Hydropneumatic water systems
  - Air lift pumps
- Service water systems, for
  - High pressure water
  - Gland seals
  - General service
- Fuel supply system, for
  - Digester heaters
  - Incinerators
  - Building heat
- Lubrication oil system, for
  - Pumps
  - Blowers
  - Motors

- Chemical supply and addition system, for
  - Disinfection
  - Sludge conditioning
  - Chemical treatment of wastewater

The reliability requirements of these systems are dependent on the function of each system in the wastewater treatment works. If a malfunction of the system can result in a controlled diversion or a violation of the effluent limitations, and the required function cannot be done by any other means, then the system shall have backup capability in the number of vital components (i. e. , pumps motors, mechanical stirrers) required to perform the system function. If the system performs functions which can be performed manually or by some other means, then backup components shall not be required.

Example: A compressed air system supplying air to air lift pumps, which are pumping return activated sludge from the secondary sedimentation basin to the aeration tanks, is an example of an auxiliary system whose failure could degrade effluent quality. If no other means for supplying air or pumping sludge were available, then this system would be required to have backup vital components, such as compressors.

Example: If the compressed air system only supplied air to pneumatic controls which could not affect effluent quality, then the system would not require any backup components.

251. Backup Components

Auxiliary systems requiring backup components shall have a sufficient number of each type of component such that the design function of the system can be fulfilled with any one component out of commission. Systems having components of different capacities shall meet this criterion with the largest capacity component out of commission. It is permissible for the backup component to be uninstalled, provided that the installed component can be easily removed and replaced. However, at least two components shall be installed.

Example: A chemical addition system supplying chlorinated water to the contact chamber and having six chlorinators and one water supply pump which just meets capacity requirements, would be required by this criterion to have one additional chlorinator and one additional pump.

252. Requirements for System, Component and Treatment Works Drains and Overflows

All system, component and works drains and overflows shall discharge to an appropriate point in the main wastewater treatment process to ensure adequate treatment. Drains flowing to a two-compartment wetwell shall be designed to discharge to either compartment of the wetwell.

252.1 Works Drains

The works shall have sufficient drains to enable all spilled or leaked raw or partially treated wastewater, sludge, chemicals or any other objectionable substance to freely drain out of the area of concern. Special attention shall be given to specifying sufficient cleanouts in drain lines which are likely to clog (e.g., drain lines handling lining). All floors within buildings and structures shall be sloped to permit complete draining.

252.2 Sump Pumps

Sump pumps shall be of a non-clog type. Sump pumps are considered vital components and each sump shall be provided with two full capacity sump pumps.

252.3 Equipment Overflows

All equipment located within buildings and which can overflow shall be equipped with an adequately sized overflow pipe. The overflow shall be directed to a gravity drain.

252.4 Surface Water Drains

The works' grounds shall be graded and drains provided in order to prohibit surface water from draining into pump wells, tanks, basins, beds, or buildings. Drains which handle uncontaminated water only shall not be connected to the contaminated drain system.

252.5 Component Dewatering

All pump wells, tanks, basins and beds, with the exception of aeration tanks, shall be designed to enable complete dewatering in a reasonable length of time in order to) minimize the component downtime for maintenance or repairs, Where practicable, these components shall have sloped bottoms to enable the units to be completely drained.

252.6 Drain Backflow

Drains shall be designed to prevent backflow from other sources which would cause flooding or violation of the effluent limitations. The drain system shall be designed to prevent the entrance of storm water during the one hundred year flood (or wave action) condition.

253. Continuity of Operation

The failure of a mechanical component in an auxiliary system shall not result in disrupting the operating continuity of the wastewater treatment system or sludge handling and disposal system to the extent that flooding, failure, malfunctioning or damage to components in those systems results.

Example: A seal water system with normal and backup water supplies must transfer automatically to the backup upon failure of the normal supply in order to protect the equipment which needs the seal water to prevent damage.

254. Emergency Fuel Storage

If a vital component requires fuel for operation, then the fuel supply system design shall include provisions for fuel storage or a standby fuel source. The capacity of stored gaseous or liquid fuel shall be determined by the Grant Applicant based on the plausible downtime of the normal fuel supply and the expected consumption rate. The emergency system shall be physically separate from the normal fuel supply up to its connection to the fuel distribution system within the works.

255. Disinfectant Addition System

The capacity of the disinfectant addition system shall be designed with due consideration of abnormal operating conditions, such as having a disinfectant contact basin out of service. It is permissible for the additional capacity required for abnormal conditions to be separate and independent from the normal disinfectant addition system.

# EPA HANDBOOK FOR IMPROVING POTW PERFORMANCE

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HANDBOOK

# IMPROVING POTW PERFORMANCE USING THE COMPOSITE CORRECTION PROGRAM APPROACH

U.S. ENVIRONMENTAL PROTECTION AGENCY

Center for Environmental Research Information
Cincinnati, Ohio 45268

October 1984

## NOTICE

This document has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

The formation of the Environmental Protection Agency marked a new era of environmental awareness in America. This Agency's goals are national in scope and encompass broad responsibility in the areas of air and water pollution, solid wastes, pesticides, hazardous wastes, and radiation. A vital part of EPA's national pollution control effort is the constant development and dissemination of new technology.

It is clear that only the most effective design and operation of pollution control facilities will be adequate to ensure continued protection of this Nation's natural resources. It is essential that we achieve the maximum performance possible of existing Publicly Owned Treatment Works (POTWs) to achieve maximum benefit from our expenditures.

The purpose of this Handbook is to provide POTW owners/administrators and the engineering community with a new source of information to be used in improving the performance of POTWs through application of the Composite Correction Program (CCP) approach. It is the intent of the manual to supplement the existing body of knowledge in this area.

This Handbook is one of several publications available from Technology Transfer to describe technological advances and present new information.

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# APPENDIX H

## DESIGN-RELATED PERFORMANCE-LIMITING FACTORS IDENTIFIED IN ACTUAL CPEs

## DESIGN-RELATED PERFORMANCE-LIMITING FACTORS

The design problems listed in this appendix were identified during actual comprehensive performance evaluations. Most of these problems have resulted in unnecessary or excessive maintenance, difficult process control, inaccurate or excessive sampling, and poor POTW performance.

These design-related problems are discussed in the context of the following categories:

| | |
|---|---|
| Plant Layout | Secondary Clarifiers |
| Flow Measurement | Return Sludge Flows |
| Bar Screens | Polishing Ponds |
| Comminutors | Chlorination |
| Grit Removal | Wasting Capability |
| Primary Clarifiers | Sludge Holding Facilities |
| Aeration Basins | Aerobic Digesters |
| Aerators | Anaerobic Digesters |
| Trickling Filters | Sludge Dewatering & Ultimate Disposal |
| ABF Towers | Laboratory Facilities |
| RBCs | Miscellaneous |

Plant Layout

- Individual process trains, without interconnection, require operation of units as if three separate activated sludge plants exist at one POTW rather than just one
- Covered basins without adequate observation access prevent observation of processes
- Return sludge air compressors are located outside and repeatedly break down
- No flow splitting flexibility to parallel units
- Bar screen located downstream from comminutor
- Freezing of influent sampler located outside
- Plant location inaccessible during inclement weather
- Excessive compressor noise
- Disinfection before polishing pond
- Parallel secondary treatment units not capable of being operated as one facility
- Inadequate piping flexibility requires shutdown of one trickling filter if one clarifier is down
- One scraper drive for primary and final clarifiers requires shutdown of both for maintenance on either
- Lack of bypasses on individual treatment units such as aeration basins, trickling filters, chlorine contact basins, etc.
- Use of a septic tank for inplant domestic and laboratory wastes and overflow from the septic tank to the plant effluent
- Both trickling filter and activated sludge processes in very small plant causes excessive operational requirements

Flow Measurement

- Discharge through a pipe rather than the control section for which the recorder is appropriate
- Downstream channel slope and geometry causes backup in Parshall flume throat

- Parshall flume oversized
- Flow measurement inaccurate due to upstream barminutor placement
- No flow recorder
- Excessive upstream velocity causes turbulent flow through Parshall flume
- Control section not accessible for inspection and maintenance
- Level transmitting instrumentation not compatible with level receiving instrumentation
- Parshall flume on POTW effluent submerged during high river flows
- Recycle flows (cooling water) included in plant flow measurement
- Rollup flow chart requires removal to observe flow for more than the preceding 4 hours
- Wires crossed in totalizer, resulting in wrong reading
- Humid influent structure causes problem with moisture-sensitive level sensor
- Flow velocity too high in Kennison nozzle
- Liquid level sensing float freezes
- Downstream bar screen backs flow into flume throat as screen plugs

Bar Screens

- Bar spacing too narrow and causes excessive blinding
- Backed-up flow released after cleaning causes hydraulic surges through aeration basin and into clarifier
- Freezing problems with mechanical bar screen located outside

Comminutors

- Repeated mechanical failure of hydraulic drive-type comminutor

Grit Removal

- Excess wear on grit screw center bearing because of exposure to grit
- Odors from organics settling out in oversized grit channel
- Pump discharge to grit chamber directed at grit buckets, and washes grit from buckets
- Grit auger not functional
- Grit auger discharges too low for disposal in truck

Primary Clarifiers

- Overloaded by excessively large trickling filter humus return pump
- Overload due to trickling filter recirculation designed to route through primary clarifier
- Improper placement of valve limits scum pumping
- Short-circuiting due to inlet baffle construction
- Preaeration in center of clarifier reduces effective clarification area

Aeration Basins

- Pipe outlet plugs with rags
- Lack of piping to operate as conventional as well as step-load or contact-stabilization activated sludge
- Receives hydraulic surges when the bar screen is cleaned and from oversized return pump on timeclock
- Loss of solids caused by flooding due to aeration basin design elevation and lack of drainage control
- Action of aeration rotors and revolving bridge and configuration of basin creates swells and voids that result in wavelike stresses on bridge
- Leakage between contact and reaeration basins of contact stabilization plant due to movable wall design
- No wall between contact and reaeration areas of contact stabilization plant

Aerators

- Inadequate capacity for oxygen transfer
- Surface mechanical aerators overheat and shut off under increased flows due to infiltration/inflow
- Inadequate DO control because blowers provided are too large
- With floating aerators, repeated breaking of cables when operated on intermittent basis
- With submerged turbine aerators, repeated downtime due to bearing and shaft failure
- Surface aerators that do not provide adequate bottom mixing in a deep oxidation ditch
- Inadequate freeboard for splashing with surface mechanical aerators
- Brush aerators provided in cold climate without ice protection
- Icing problems with surface mechanical aerators
- Rag accumulation on surface mechanical aerators
- Inadequate DO control

Trickling Filters

- Recirculation only through primary clarifier
- Inadequate capacity of trickling filter arms
- Poor flow splitting to trickling filters

ABF Tower

- Inadequately sized for organic load
- Undersized pipe carrying tower underflow back to recirculation tank
- No flexibility to vary percent tower underflow returned to recirculation tank
- Sludge return and tower recycle flow are directed into the same pipe, which limits their volume recycled
- No flow measurement on direct recycle flow around tower

APPENDIX H (Continued)

RBCs

- No positive flow splitting to various trains
- No access provided through covers to take dissolved oxygen measurements
- Inadequate shaft design causes excessive downtime

Secondary Clarifiers

- Poor flow splitting to clarifiers
- Poor development of surface area with weirs
- Sludge scraper mechanism directing contercurrent to wastewater flow
- Hydraulically connected clarifiers not of the same elevation causes unequal flow splitting
- Freezing during cold weather
- Inlet and outlet on circumference, a large diameter, a large design overflow rate, and failure to consider process recycle flows cause problems with hydraulic washout of solids
- Scum returned to aeration basin; no ultimate disposal of scum
- Combined primary and final clarifier unit allows mixing of two with scraper mechanism
- Hydraulic restriction causes submerged overflow weirs
- Short-circuiting due to inlet baffle construction
- Placement of trickling filter recirculation drawoff overloads final clarifier
- Weirs on single launder not balanced to pull evenly from each side
- No skimming device
- Shallow depth promotes thin underflow concentrations and solids washout

Return Sludge Flows

- Constant-speed centrifugal pumps make it difficult to adjust flow
- Oversized constant-speed pumps provided
- Return sludge flow not visible at any point
- No measurement
- Single pump returning from multiple clarifiers; balancing return flow difficult
- Variable-speed return pumps too large even at lowest setting
- Plugging of telescoping valves at lower flows
- Sludge returned to a point near the outlet of the aeration basin
- Not accessible for sampling
- Piping prohibits return sludge flow for several hours while sludge is being removed from the aerobic digester
- Measurement with 90° V-notch weir not sensitive enough for needed flow adjustments
- Oversized pump on timeclock draws down final clarifier, then hydraulically overloads aeration basin
- Waste piping and appurtenances require excess return rate to accomplish wasting
- Stilling box ahead of V-notch weir too small
- Location of return measurement requires operator to walk out on narrow wall over basins, resulting in unsafe working conditions
- Sludge return from clarifiers controlled by plug valve into wet well. Excess operator time required to match variable-speed pump with valve-controlled rate
- Return adjustment requires alternate operation of pump from first clarifier, second clarifier, and both clarifiers to set desired total return
- Partial plugging with rags of butterfly valve used for return sludge flow control
- Rapid withdrawal sludge removal designed without sampling or adjustment capability from various ports

Polishing Ponds

- No pond bypass
- Sludge wasted to polishing pond
- Pond located after disinfection

Chlorination

- Chlorine diffuser located at center of contact tank rather than at inlet
- Chlorine diffuser located at outlet of contact tank
- Single contact tank prohibits disinfection during cleaning and discourages cleaning of contact basin
- Rotometer on chlorinator too large for present application
- Poor mixing
- Chlorine dosage paced by effluent flow, but filter backwash water removed from combined contact-backwash storage tank shuts off chlorination until it is again filled and discharging
- Inadequate chlorine contact time in outfall pipe
- No depth control device on contact tank results in inadequate contact time and short-circuiting
- Short-circuiting over baffles during high flows
- Short-circuiting due to inlet design

Wasting Capability

- No digester or sludge holding facility; inadequate drying beds
- Downtime of exotic sludge treatment facility causes inadequate wasting
- Wasting capability only from mixed liquor requires excessive waste volume
- Insufficient wasting capacity
- Sludge lagoons undersized

- No waste flow measurement
- Partial plugging of waste pump prevents use of pumping rate to calculate waste volume
- Valve choice for directing return sludge to waste requires excess operator time
- Undersized waste pump

Sludge Holding Facilities

- Odors from unaerated, uncovered sludge storage
- Undersized storage capacity given ultimate sludge disposal limitations
- Potential gas buildup problem with covered, unaerated sludge storage

Aerobic Digesters

- High groundwater and pressure relief valve prevents batch operation
- Inadequate air supply
- Inadequate supernating capability
- Undersized
- Pump used for sludge removal prevents thickening of sludge
- Small digesters and minimum freeboard make foam containment difficult
- Freezing problems
- Common wall with aeration basin structurally insufficient to allow batch operation
- Provided with "automatic" supernating device that cannot work

Anaerobic Digesters

- Inadequate supernatant drawoffs
- With multiple units, inflexibility to waste to desired primary digester

- Plugging problem between bottom of primary digester and second-stage digester
- Water seal on sludge recirculation pump loads digester with cold water
- Sludge pumping line from clarifier plugs prevents digester loading at concentrations above about 6 percent
- No gas meters
- No mixing
- Cold digester produces poor supernatant quality and poor digestion
- Single gas meter for two digesters
- Uninsulated heating pipes outside

Sludge Dewatering & Ultimate Disposal

- Truck ramp too steep for use during winter
- Excessive maintenance on sludge incineration facilities
- Insufficient sludge drying lagoons
- Disposal of sludge in polishing lagoon
- Truck capacity too small for sludge produced
- Insufficient drying beds for wet or cold weather operation
- Land application not possible during certain times of the year; no alternate disposal or storage

Laboratory Facilities

- Vibrations prevent use of scale
- Inadequately equipped
- Humidity difficult to work in and hard on equipment
- Noise from blowers limits usability
- Poor lighting
- Insufficient floor space

Miscellaneous

- Stabilization of sludge with chlorine releases heavy metals to recycled supernatant
- Wooden gates in flow diversion structure swell and cannot be removed
- No automatic restart after power outage
- Butterfly valve used between mixed liquor and final effluent leaks mixed liquor into effluent
- Undersized raw lift pumps

APPENDIX I
TABLE OF CONTENTS
WWTP SYSTEM OPERATING MANUAL

Routine Operation and Operating Procedures
Emergency, Alternate and Manual Operation
Process Monitoring, Laboratory Testing and Data Collection
Startup, Normal Shutdown, and Emergency Shutdown Procedures
Equipment Monitoring, Startup, Shutdown, and Isolation Process Troubleshooting
Safety and Housekeeping (Specific Procedures for This Process)
Figures-Process Flow Diagram with Expected Values
Piping Schematic Diagram (Color Coded)
Process and Equipment Layout, Control Location
Other Plan and Elevation Views as Needed

Tables
- Process Capabilities and Limitation
- Design Data for Equipment Layout, Control Location
- Control and Instrument Settings (as appropriate)
- Troubleshooting
- Data Collection and Monitoring Forms
- Valve Position for Various Operating Modes

Chapter 5 - Discharge Requirements and Effluent Monitoring

Summary of Discharge Requirements
Monitoring Program to Verify Compliance

Tables
- Discharge Requirements
- Monitoring and Testing Schedule

Chapter 6 - Sampling and Laboratory Procedures

Sampling Procedures
Significance of Wastewater Testing
Laboratory Testing

Table
- Approved Analytical Procedures

Chapter 7 - Staffing

Staffing Requirements

APPENDIX I (Continued)

APPENDIX J
TABLE OF CONTENTS
WASTEWATER EQUIPMENT MAINTENANCE AND REPAIR MANUAL

Troubleshooting
Safety and Housekeeping
Figures- Schematic Diagrams
System and Equipment Layout, Control Location

Tables- Design Data
Control and Instrument Settings
Troubleshooting
Valve Schedule and Function

Chapter 5 - Vendor Literature (one section per equipment item listed on the MEL)

Function
Operating Characteristics
Limiting Conditions
Startup and Shutdown
Normal and Emergency Operation
Controls
Safety during Operation and Maintenance
Preventive Maintenance and Schedule
Corrective Maintenance
Troubleshooting
Lubrication and Alternate Lubricants
Required Tools
Recommended Spare Parts
Electrical and Control Schematics
Warranty
Test Data and Approved Shop Drawings

## APPENDIX K
## PRE-STARTUP INSPECTION RECORD

Plant Name and Location

| Equip. No. | Equipment Description | Dry-Run Inspection and Corrective Action | Date | By | Wet-Run Test and Corrective Action | Date | Certified OK Date | Certified OK By |
|---|---|---|---|---|---|---|---|---|
| 1001 | Comminutor | | 1/23 | | OK | 2/17 | 2/17/95 | |
| 1057 | Raw Sewage Pump #1 | Loose mountings - contractor will correct by 1/24/95 | 1/23 | | Undue vibration - supplier will fix by 3/3/95 | 2/21 | 3/5/95 | |
| | | Impeller cracked - supplier will replace by 2/3/95 | 1/23 | | | | | |
| 1075 | Grit Chamber #1 | OK | 1/23 | | Dead spot - contractor will fix by 2/18/95 | 2/17 | 2/18/95 | |
| | Connection of pipe to raw sewage pump #4 | OK | 1/23 | | Pressure leak - supplier will repair by 2/19/95 | 2/17 | 2/19/95 | |

# REFERENCES

NOTE: THE FOLLOWING REFERENCED DOCUMENTS FORM A PART OF THIS HANDBOOK TO THE EXTENT SPECIFIED HEREIN. USERS OF THIS HANDBOOK SHOULD REFER TO THE LATEST REVISIONS OF CITED DOCUMENTS UNLESS OTHERWISE DIRECTED.

## FEDERAL/MILITARY SPECIFICATIONS, STANDARDS, BULLETINS, HANDBOOKS, AND NAVFAC GUIDE SPECIFICATIONS:

Unless otherwise indicated, copies are available from the Naval Publishing and Printing Service Office (NPPSO), Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

| | |
|---|---|
| MIL-HDBK-XXXX | Wastewater Design Handbook |
| MIL-HDBK-XXXX | Wastewater Operations and Maintenance (O&M) Handbook |

## AIR FORCE REGULATIONS, MANUALS, INSTRUCTIONS, AND GUIDES:

Unless otherwise indicated, copies are available from the Air Force Publications Distribution Center, 2800 Eastern Boulevard, Baltimore, MD 21220-2896.

| | |
|---|---|
| AFI 32-1032 | Planning and Programming Real Property Maintenance Projects Using Appropriated Funds |
| AFI 32-7002 | Environmental Information Management System |
| AFI 32-7061 | Environmental Impact Analysis Process |
| AFM 88-11 | Domestic Wastewater Treatment (Vol. 3) |
| AFMAN 65-506 | Economic Analysis |

Unless otherwise indicated, copies are available from AFCEE/CME, Brooks AFB, TX 78235.

| | |
|---|---|
| | Air Force Project Manager's Guide for Design and Construction |
| CTL 90-1 | Management of the MILCON Planning and Execution Process |

Unless otherwise indicated, copies are available from AFCESA/CES, 139 Tyndall AFB, FL 32403-5319.

| | |
|---|---|
| | Environmental Compliance POM Handbook |
| ETL 88-4 | R&M Design Checklist |
| ETL 89-2 | Standard Guidelines for Submission of Facility Operating and Maintenance Manuals |
| ETL 95-2 | Preparation of Requirements and Management Plan (RAMP) Packages for Military Construction (MILCON) Program Projects |

U.S. ARMY CORPS OF ENGINEERS REGULATIONS:

Unless otherwise indicated, copies are available from the U.S. Army Corps of Engineers Publications Depot, 2803 52nd Ave., Hyattsville, MD 20781.

| | |
|---|---|
| ER 1110-345-723 | Engineering and Design Systems Commissioning Procedures |
| ER 25-345-1 | Systems Operation and Maintenance Document |

OTHER GOVERNMENT DOCUMENTS AND PUBLICATIONS:

| | |
|---|---|
| A-106 | Federal Agency Pollution Abatement and Prevention Project Plan (Office of Management and Budget Circular available through Federal Register/Depository Libraries) |

Unless otherwise indicated, copies are available from the U.S. Department of Commerce National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161.

| | |
|---|---|
| EPA 430-99-74-001 | Technical Bulletin: Design Criteria for Mechanical, Electrical, and Fluid System and Component Reliability (NTIS No. PB-227-008) |
| EPA 625/6-84-008 | EPA Handbook for Improving POTW Performance (NTIS No. PB 88184007) |

Unless otherwise indicated, copies are available from Education Resource Information Center, 1200 Chambers Road, Room 310, Columbus, OH 43212.

| | |
|---|---|
| PB 85231165/AS | Infiltration/Inflow - I/I Analysis and Project Certification |
| PB-215-494 | Federal Guidelines: Design, Operation and Maintenance of Wastewater Treatment Facilities, FWQA |

NONGOVERNMENT PUBLICATIONS:

WATER ENVIRONMENT FEDERATION (WEF)

Design of Municipal Wastewater Treatment Plants (Vols. I & II), WEF Manual of Practice No. 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS

Design of Municipal Wastewater Treatment Plants (Vols. I & II), Manual and Report on Engineering Practice, No. 76.

(Available from ASCE, 345 East 47th St., New York, New York 10017-2398 or from WEF, 601 Wyethe St., Alexandria, Virginia 22314-1994.)

AUTHORED PUBLICATIONS:

Hydromantis, Inc. CAPDET-PC: A Computer Program for the Design and Cost Estimation of Wastewater Treatment Facilities. Hamilton, Ontario.

Operation of Wastewater Treatment Plants: A Field Study Training Program. Prepared by California State University, Sacramento, Department of Civil Engineering, for the EPA. 1990.

# GLOSSARY

| Abbreviation or Acronym | Definition |
|---|---|
| A-E | Architect-Engineer |
| AFCEE | Air Force Center for Environmental Excellence |
| AFCESA | Air Force Civil Engineering Support Agency |
| AFFARS | Air Force Federal Acquisition Regulations Supplement |
| ASCE | American Society of Civil Engineers |
| BCE | base civil engineer(ing) |
| BCP | Base Comprehensive Plan |
| CA | Construction Agent |
| CEC | Directorate of Military Construction |
| CES | Systems-Engineering Directorate |
| CEV | Directorate of Environmental Quality |
| CM | Construction Manager |
| DA | Design Agent |
| DI | Design Instruction |
| DM | Design Manager |
| DMEL | design master equipment list |
| EA | environmental assessment |
| ECAMP | Environmental Compliance Assessment and Management Program |
| EIAP | Environmental Impact Analysis Process |
| EIS | environmental impact statement |
| EOM&RM | Equipment Operating, Maintenance, and Repair Manual |

| | |
|---|---|
| EPA | Environmental Protection Agency |
| FWQA | Federal Water Quality Administration/Act |
| GFE | Government-furnished equipment |
| I/I | infiltration/inflow |
| LCC | life-cycle cost |
| MAJCOM | major command |
| MEL | master equipment list |
| MILCON | military construction |
| NOV | notice of violation |
| NPDES | National Pollutant Discharge Elimination System |
| O&M | operation and maintenance |
| OMTAP | Operations, Maintenance, and Training Assistance Program |
| P&I | process and instrumentation |
| PC | predefinition conference |
| PD | project definition |
| PI | Planning Instruction |
| POTW | publicly owned treatment works |
| R&M | reliability and maintainability |
| RAMP | Requirements and Management Plan |
| SOPs | standard operating procedures |
| WEF | Water Environment Federation |
| WWTP | wastewater treatment plant |

# CONCLUDING MATERIAL

Custodian:
Air Force - HQ AFCESA/CES

Preparing activity:
Air Force - 50
(Project FACR-F150)

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
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| | MIL - HDBK - 353 | 96/08/17 |

3. DOCUMENT TITLE
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4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

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