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SUPPLIMENT TO FEDERAL GUIDELINES: DESIGN, OPERATION, AND MAINTENANCE OF WASTEWATER TREATMENT FACILITIES

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

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Water Program Operations
Washington, D.C. 20460

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. 20460

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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.

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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.

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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 I, 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 Facility

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 capcity 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 <u>Aeration Blowers or Mechanical Aerators</u>

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 <u>Air Diffusers</u>

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 <u>Chemical Flash Mixer</u>

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 or 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.

212.3.2.3 Air Diffusers

The Reliability Class I requirements shall apply.

212.3.3 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 Anaerobic 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 Mixing 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 Filter

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 cross-connect 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 221.1 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.

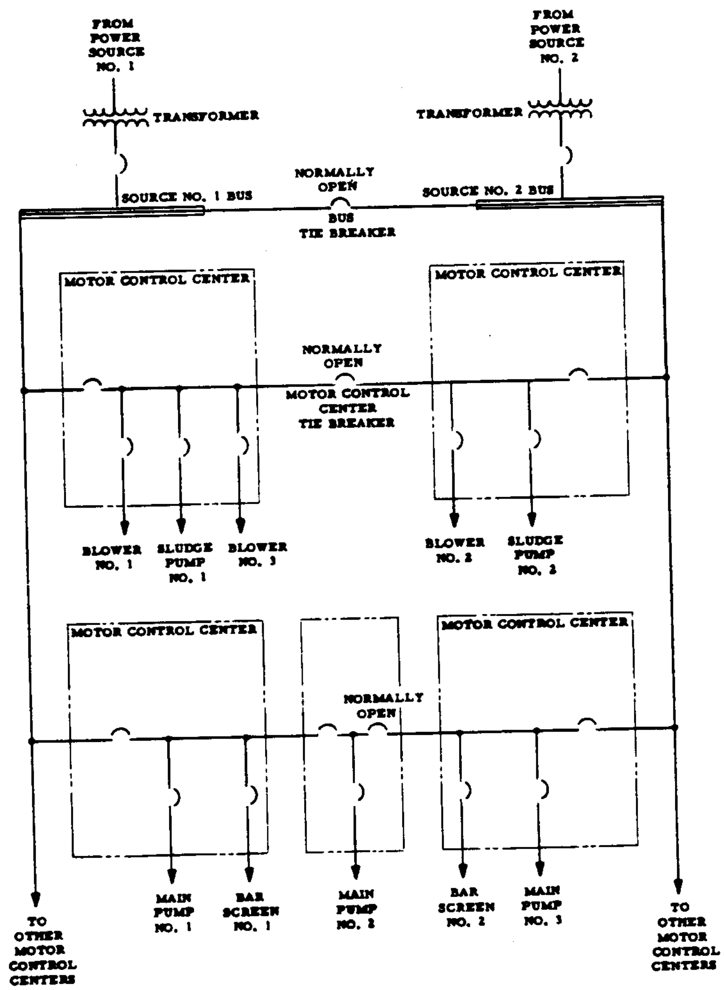
> Example: An example for feeder distribution and bus transfer which meets these criteria is shown in Figure 1. The two power sources from utility substations are connected to the motor control centers through circuit breakers. A circuit breaker is provided to cross-connect the two motor control centers 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 <u>Explosion Proof Equipment</u>

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 <u>Routing of Cabling</u>

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. Maintainability

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. <u>Alarms and Annunciators</u>

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 annunciators to be tested and verified to be in working order.

244. <u>Alignment and Calibration of Equipment</u>

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 lime). 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.

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