3. Mix design criteria shall be as follows (Marshall Method ASTM D 1559):

A. Marshall Stability (35 blows/side) five hundred pounds (500 lbs.) minimum;

B. V.M.A., % 15 minimum;

C. Air Voids, % 0–2 (target value—1%); and

D. Asphalt Cement, % (wt. of total mix) 6.5–9.5.

4. The liner should be constructed in accordance with the requirements specified in *Missouri Standard Specification for Highway Construction*, Missouri Highway and Transportation Commission, section 403, Asphaltic Concrete Pavement, except as modified or supplemented by the following:

A. The liner shall be four inches (4") thick at a minimum;

B. The liner shall be constructed in two (2) lifts, with each lift being approximately equal to one-half (1/2) the total surface thickness to within plus or minus one-half inch (1/2") tolerance;

C. Longitudinal joints between paver passes for the second layer should be offset from the joints in the lower layer by three feet (3');

D. Transverse joints in the second layer shall be offset from joints in the lower layer by at least three feet (3');

E. A tack coat of an emulsion such as CSS-1 or CSS-1h diluted one to one (1:1) with water and applied at an approximate rate of ten hundredths gallons (.10 gals.) per square yard should be applied between asphaltic lifts and on all vertical joints prior to placement of the next and/or adjacent lift. The tack coat between two (2) lifts should be uniformly distributed. All tacking should be done in accordance with MSSHC section 407, except as modified as described here; and

F. Placement of the hot-mix asphalt mixture shall be accomplished when the ambient temperature is above and fifty degrees Fahrenheit (50°F.);

5. Upon completion of the construction of the hot-mix asphalt concrete liner and prior to filling of the basin with water or sewage, a surface treatment of asphalt cement should be applied to the entire basin to ensure a watertight basin and to reduce the rate of oxidation of the surface of the lining. An AC-20 should be used and applied at a rate of about twenty-five hundredths gallons (.25 gals.) per square yard. Two (2) applications may be necessary to achieve this rate. The surface should be clean, dry and free from loose material prior to the application;

6. The sides of the basin should be designed so that paving equipment may operate or on a four to one (4:1) slope (horizontal to vertical). The asphaltic surface should be extended up and onto the berm of the basin for a distance of at least three feet (3') beyond the point of intersection of the berm and side slope. This asphalt cap should be constructed around the basin; and

7. The subgrade or base for the slopes and bottom shall be constructed of MSSHC type 2 base material and shall be a minimum of one and one-half inches (1 1/2") and compacted to ninety-five percent (95%) standard proctor density. Prior to construction of the asphaltic concrete liner, the subgrade soil (type 2 base) on all side slopes should be treated with soil sterilants to prevent weed growth through the lining.

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed July 17, 1961, effective July 27, 1961. Amended: Filed Oct. 3, 1962, effective Oct. 13, 1962. Amended: Filed Dec. 4, 1975, effective Dec. 14, 1975. Rescinded and readopted: Filed Nov. 4, 1988, effective April 15, 1989.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.021 Individual Sewage Treatment Systems Standards
(Rescinded March 30, 1999)

AUTHORITY: section 644.026, RSMo 1986. Original rule filed Nov. 14, 1988, effective April 15, 1989. Rescinded: Filed July 13, 1998, effective March 30, 1999.

10 CSR 20-8.030 Design of Sewage Works
(Rescinded August 13, 1979)

AUTHORITY: section 204.026, RSMo Supp. 1973. Original rule filed July 17, 1961, effective July 27, 1961. Amended: Filed Oct. 3, 1962, effective Oct. 13, 1962. Amended: Filed Dec. 4, 1975, effective Dec. 14, 1975. Rescinded: Filed May 4, 1979, effective Aug. 13, 1979.

***Op. Atty. Gen. No. 92, Bockenkamp (3-24-75).** The City of Farmington may impose user charges pursuant to section 204.026(18), RSMo (Supp. 1973), to cover costs of operation and/or future expansion of a public sewer treatment facility constructed pursuant to a grant of federal funds under 33 USC, Sections 1281-1292, without the necessity of an election as provided in section 71.715, RSMo (1969).*

***Op. Atty. Gen. No. 229, Smith (8-20-73).** Municipalities and sewer districts have authority to make the user charges to industries required by the Federal Water Pollution Control Act amendments of 1972 and to establish the reserves for future expansion or reconstruction.*

10 CSR 20-8.110 Engineering—Reports, Plans and Specifications

*PURPOSE: The following criteria have been prepared as a guide for the preparation of engineering reports or facility plans and detail plans and specifications. This rule is to be used with rules 10 CSR 20-8.120—10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers **Recommended Standards for Sewage Works** and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred

and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons (85.4m^3) per day or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) Engineering services are performed in three (3) steps—engineering report or facilities plan; preparation of construction plans, specifications and contractual documents; and construction compliance, inspection, administration and acceptance. These services are generally performed by engineering firms in private practice but may be executed by municipal, state or federal agencies. All reports, plans and specifications should be submitted at least sixty (60) days prior to the date upon which action by the agency is desired, or in accordance with NPDES or other schedules. The documents, at the appropriate times, should be submitted for formal approval and should include the engineer's report (facilities plan) and design drawings and specifications. For nongrant projects which are unusual or complex, it is suggested that the engineer meet with the appropriate regional office to discuss the project and that preliminary reports be submitted for review prior to the preparation of final plans and specifications. These documents are used by the owner in programming future action, by the agency to evaluate probable compliance with statutes and regulations, by bond attorneys and investment houses to develop and evaluate financing and by the news media. Preliminary reports and plans shall broadly describe existing problems; consider methods for alternate solutions including site and/or route selection; estimate capital and annual costs; and outline steps for further project implementation, including financing and approval by regulatory agencies. No approval for construction can be issued until final, detailed plans and specifications have been submitted to the agency and found to be satisfactory.

(4) Engineering Report or Facility Plan. For construction grant projects the federal regulations describe requirements for the facility plan which must be met. The engineering report, for nongrant projects, assembles basic information; presents design criteria and assumptions; examines alternate projects with preliminary layouts and cost estimates; describes financing methods giving anticipated charges for users; reviews organizational and staffing requirements; offers a conclusion with a proposed project for client consideration; and outlines official actions and procedures to implement the project. The concept, including process description and sizing, factual data and controlling assumptions and considerations for the functional planning of sewerage facilities are presented for each process unit and for the whole system. These data form the continuing technical basis for detail design and preparation of construction plans and specifications. Architectural, structural, mechanical and electrical designs are usually excluded. Sketches may be desirable to aid in presentation of a project. Outline specifications of process units, special equipment, etc., are occasionally included.

(A) Format for Content and Presentation. It is urged that the following paragraphs be utilized as a guideline for content and presentation of the project engineering report to the agency for review and approval.

1. Title. The wastewater facilities report—collection, conveyance, processing and discharge of wastewater.

2. Letter of transmittal. A one (1) page letter typed on the firm's letterhead and bound into report should include submission of report to the client, statement of feasibility of recommended project, acknowledgment to those giving assistance and reference to project as outgrowth of approved area-wide wastewater management plans.

3. Title page. Title of project; municipality, county or other sponsoring agency; names of officials, managers, superintendents; name and address of firm preparing report; seal and signature of the professional engineer in charge of project.

4. Table of contents. (Number all pages; cross-reference by page number.) Section heading, chapter heading and sub-headings; maps; graphs; illustrations, exhibits; diagrams; appendices.

5. Summary. Highlight, very briefly, what was found from the study.

A. Findings. Population—present, design (when), ultimate; land use and zoning—portion per residential, commercial, industrial, greenbelt, etc.; wastewater characteristics and concentrations—portions of total hydraulic, organic and solids loading attributed to residential, commercial and industrial fractions; collection system projects—immediate needs to implement recommended project, deferred needs to complete recommended project and pump stations, force mains, appurtenances, etc.; selected process and site—characteristics of process expected for effluent quality and description of site, environmental assessment of selected process; receiving waters—existing water quality and quantity, classifications and downstream water uses and impact of project on receiving water; proposed project—total project costs, total annual expense requirements for debt service; operation, personnel and operation and nonpersonnel; finances—indicate financing requirements and typical annual charges; organization—administrative control necessary to implement project, carry through to completion, operate and maintain wastewater facility and system; and changes—alert client to situations that could alter recommended project.

B. Conclusions. Project(s) recommended to client for immediate construction, suggested financing program and other.

C. Recommendations. Summarized, step-by-step actions, for client to follow to implement conclusions—official acceptance of report; adoption of recommended project; submission of report to agency for review and approval; authorization of engineering services for approved project (construction plans, specifications, contract documents, etc.); legal services; enabling ordinances, resolutions, etc., required; adoption of sewer-use ordinance; adoption of operating rules; financing program requirements; organization and administration (structure, personnel, employment, etc.); time schedules—implementation, construction, completion dates, reflecting applicable hearings, stipulations, abatement orders.

6. Introduction. Purpose—reasons for report and circumstances leading up to report; scope—coordination of recommended project with approved comprehensive master plan and guideline for developing the report.

7. Existing conditions and projections.

A. Planning period. Total period of time for which program is to be studied.

B. Land use. Existing area, expansion, annexation, intermunicipal service, ultimate planning area; drainage basin, portion covered; and residential, commercial and industrial land use, zoning, population densities, industrial types and concentrations.

C. Demographic and economic data. Population growth, trends, increase during design of life of facility (graph); assessed valuation, tax structure, tax rates, portions for residential, commercial, industrial property; employment, from within and outside service area; transportation systems, effect on commuter influx, exempt property (schools, colleges, churches, foundations, governmental agencies, etc.) and effect on project; and costs of present water and wastewater services.

D. General. Topography, general geology and effect on project; and meteorology, precipitation, runoff, flooding, etc. and effect on project.

E. Forecasts of flow and waste loads. Water consumption (total, unit, industrial); wastewater flow pattern, peaks, total design flow; physical, chemical and biological characteristics and concentrations; residential, commercial, industrial, infiltration/inflow fractions, considering organic, solids, toxic, aggressive, etc. substances; tabulate each fraction separately and summarize.

F. Local regulations. Existing ordinances and rules including defects and deficiencies, etc.; recommended amendments, revisions or cancellation and replacement; sewer-use ordinance (toxic, aggressive, volatile, etc. substances) surcharge based on volumes and concentration for industrial wastewaters; existing contracts and agreements (intermunicipal, etc.); and enforcement provisions including inspection, sampling, detection, penalties, etc.

8. Existing facilities evaluation.

A. Existing collection system. Inventory of existing sewers; isolation from water supply wells; adequacy to meet project needs (structural condition, hydraulic capacity tabulation); gauging and infiltration/inflow analysis; overflows and required maintenance, repairs, improvements and methods for control; outline repair, replacement and stormwater separation requirements; evaluation of costs for treating infiltration/inflow versus cost for rehabilitation of system; establish renovation priorities, if selected; present recommended annual program to renovate sewers; and indicate required annual expenditure.

B. Existing treatment plant site. Area for expansion, terrain, subsurface conditions; isolation from habitation; isolation from water supply structures; enclosures of units, odor control, landscaping, etc.; and flooding (predict elevation of twenty-five (25) and one hundred (100)-year flood stage).

C. Existing facilities. Tabulate capacities and adequacy of units (wastewater treatment, sludge processing and sludge disposal); relationship and/or applicability to proposed project; age and condition; adaptability to different usages; structures to be retained, modified or demolished; and outfall.

D. Existing wastewater characteristics. Water consumption from records (total, unit, industrial); wastewater flow pattern, peaks, total design flow (verify accuracy of installed metering equipment); physical, chemical and biological characteristics and concentrations; residential, commercial, industrial, infiltration/inflow fractions, considering organic solids, toxic, aggressive, etc. substances; tabulate each fraction separately and summarize.

E. Evaluation of unsewered communities. Types of existing residential systems and their construction of deficiencies, operational problems and number of residents served.

9. Basic project development.

A. Proposed collection system. Inventory of proposed additions, isolation from water supply wells, reservoirs, facilities, etc.; area of service; unusual construction problems; utility interruption and traffic interference; restoration of pavements, lawns, etc.

B. Design wastewater characteristics. Character of wastewater necessary to insure amenability to process selected; need to pretreat industrial wastewater before discharge to sewers; portion of residential, commercial, industrial wastewater fractions to comprise projected growth.

C. Receiving water considerations. Upstream wastewater discharges; receiving water base flow; characteristics (concentrations) of receiving waters; downstream water uses including water supply, recreation, agricultural, industrial, etc.; impact of proposed discharge on receiving waters; tabulation of plant performance versus receiving water requirements; listing of effluent characteristics; and correlation of plant performance versus receiving water requirements. A determination from the Department of Natural Resources, Division of Geology and Land Survey, of whether the receiving stream is losing or gaining shall be included in the engineering report (facility plan).

D. Effluent limitations. Allowable concentration of pollutants in the effluent based on 10 CSR 20-7.015 Effluent Regulations.

E. Treatment plant site requirements. Compare advantages and disadvantages relative to cost, hydraulic requirements, flood control, accessibility, enclosure of units, odor control, landscaping, etc. and isolation with respect to potential nuisances and protection of water supply facilities.

F. Alternatives. Consider such items as regional solutions, optimum operation of existing facilities, flow and waste reduction, location of facilities, phased construction, necessary flexibility and reliability, sludge disposal, alternative treatment sites, alternative collection and treatment processes and institutional arrangements.

G. Alternative process and sites. Describe and delineate (line diagrams); preliminary design for cost estimates; estimates of total project cost (dated, keyed to construction cost index, escalated, etc.); advantages and disadvantages of each; individual differences, requirements, limitations; characteristics of process output; comparison of process performances; environmental assessment of each (including both primary and secondary impacts); operation and maintenance expense and energy requirements; and annual expense requirements (tabulation of annual operation, maintenance, personnel, debt obligation for each alternate).

H. Selected process and site. Identify and justify process and site selected; adaptability to meet initial and future needs; environmental assessment; outfall location; and describe immediate and deferred construction.

I. Project financing. Review applicable, financing methods; effect of state and federal assistance; assessment (a combination of methods should most probably be applied to distribute cost and expenses as equitably as possible in relation to benefit received) by valuation, front foot, area unit or other benefit; charges (a combination of methods should most probably be applied to distribute cost and expenses as equitably as possible in relation to benefit received) by connection, occupancy, readiness-to-serve, water consumption, industrial wastewater discharge, etc.; existing debt service requirements; bond retirement schedule; tabulate all expenses; show how representative properties and users are to be affected; and show anticipated typical annual charge to user and nonuser.

J. Legal and other considerations. Needed enabling legislation, ordinances, rules; statutory requirements and limitations, contractual considerations for intermunicipal cooperation; and public information and education.

(B) Appendices. Technical Information and Design Criteria.

1. Collection system. Design tabulation—flow, size, velocities, etc.; regulator or overflow design; pump station calculations including energy requirements; special appurtenances; stream crossings; and system map (report size).

2. Process facilities. Criteria selection and basis; hydraulic and organic loadings—minimum, average, maximum and effect (wastewater and sludge processes); unit dimensions; rates and velocities; detentions concentrations; recycle; chemical additive control; physical control and flow metering; removals; effluent concentrations, etc. (include a separate tabulation for each unit to handle solid and liquid fractions); energy requirement; and flexibility.

3. Process diagrams. Process configuration, interconnecting piping, processing, flexibility, etc.; hydraulic profile; organic loading profile; solids profile; solids control system; and flow diagram with capacities, etc.

4. Laboratory. Physical and chemical tests and frequency to control process; time for testing; space and equipment requirements; and personnel requirements—number,

type, qualifications, salaries, benefits (tabulate).

5. Operation and maintenance. Routine special maintenance duties; time requirements; tools, spare parts, equipment, vehicles, safety, etc.; maintenance workspace and storage; and personnel requirements—number, type, qualifications, training, salaries, benefits (tabulate).

6. Office space for administrative personnel and records.

7. Personnel services. Locker rooms and lunch rooms.

8. Chemical control. Processes needing chemical addition; chemicals and feed equipment; tabulation of amounts and unit and total costs.

9. Collection systems control. Cleaning and maintenance; regulator and overflow inspection and repair; flow gauging; industrial sampling and surveillance; ordinance enforcement; equipment requirements; trouble-call investigation; and personnel requirements—number, type, qualifications, salaries, benefits, training (tabulate).

10. Control summary. Personnel; equipment; chemicals, utilities, list power requirements of major units; and summation.

11. Support data. Outline unusual specifications, construction materials and construction methods; maps, photographs, diagrams; and other.

(5) Preliminary Design Review. On all grant projects the consulting engineer shall submit the project for review at approximately a twenty percent (20%) design stage. The design information to be submitted shall include a layout of the study area delineating all proposed improvements, including subareas, with contributing flows and design populations. All calculations regarding sizing of lift stations and treatment plan units shall also be included. A conference between the consultant and the review engineer may be arranged to discuss the project.

(6) Plans.

(A) General. All plans for sewage works shall bear a suitable title showing the name of the municipality, sewer district or institution; and shall show the scale in feet, a graphical scale, the north point, data and the name of the engineer, certificate number and imprint of his/her registration seal. A space should be provided for signature and/or approval stamp of the appropriate reviewing and approving officials and/or agencies. The plans shall be clear and legible (suitable for microfilming). They shall be drawn to a scale which will permit all necessary information to be plainly shown. The size of the plans generally should not be larger than thirty by forty-two inches (30" × 42") (76 cm × 107 cm). Datum used should be indicated. Locations and logs of test borings, when made, shall be shown on the plans. Blueprints shall not be submitted. Detail plans shall consist of plan views, elevations, sections and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the works. Include dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels and ground elevations.

(B) Plans of Sewers.

1. General plan. A comprehensive plan of the existing and proposed sewers shall be submitted for projects involving new sewer systems and substantial additions to existing systems. This plan shall show the following:

A. Geographical features. Existing or proposed streets and all streams or water surfaces shall be clearly shown. Contour lines at suitable intervals should be included. The direction of flow in all streams and high and low water elevations of all water surfaces at sewer outlets and overflows shall be shown. The boundary lines of the municipality and the sewer district or area to be sewered shall be shown.

B. Sewers. The plan shall show the location, size and direction of flow of all existing and proposed sanitary and combined sewers draining to the treatment works concerned.

2. Detail plans. Detail plans shall be submitted. Profiles should have a horizontal scale of not more than one hundred feet (100') to the inch (12 m to the cm) and a vertical scale of not more than ten feet (10') to the inch (12 dm to the cm). Plan view should be drawn to a corresponding horizontal scale. Plans and profiles shall show—

A. Location of streets and sewers;

B. Line of ground surface, pipe size, length between manholes, invert and surface elevation at each manhole, grade of sewer between each two (2) adjacent manholes and pipe material and type where special construction features are required. All manholes shall be numbered on the plan and correspondingly numbered on the profile. Where there is any question of the sewer being sufficiently deep to serve any residence, the elevation and location of the basement floor shall be plotted on the profile of the sewer which is to serve the house in question. The engineer shall state that all sewers are sufficiently deep to serve adjacent basements except where otherwise noted on the plans;

C. Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, etc.;

D. All known existing structures and utilities both above and below ground which might interfere with the proposed construction, particularly water mains, gas mains and storm drains; and

E. Special detail drawings, made to a scale to clearly show the nature of the design and the following particulars: all stream crossings and sewer outlets, with elevations of the stream bed and of normal and extreme high and low water levels; details of all special sewer joints and cross sections; details of all sewer appurtenances such as manholes, lampholes, inspection chambers, inverted siphons, regulators, tide gates and elevated sewers.

(C) Plans of Sewage Pumping Stations.

1. Location plan. A plan shall be submitted for projects involving construction or revision of pumping stations. This plan shall show the following: the location and extent of the tributary area; any municipal boundaries with the tributary area; the location of the pumping station and force main; and pertinent elevations.

2. Detail plans. Detail plans shall be submitted showing the following, where applicable:

A. Topography of the site;

B. Existing pumping station;

C. Proposed pumping station, including provisions for installation of future pumps or ejectors;

D. Elevation of high water at the site and maximum elevation of sewage in the collection system upon occasion of power failure;

E. Maximum hydraulic gradient in downstream gravity sewers when all installed pumps are in operation; and

F. Test boring and groundwater elevations.

(D) Plans of Sewage Treatment Plants.

1. Location plan. A plan shall be submitted showing the sewage treatment plant in relation to the remainder of the system. Sufficient topographic features shall be included to indicate its location with relation to streams and the point of discharge of treated effluent.

2. General layout. Layouts of the proposed sewage treatment plant shall be submitted showing topography of the site; size and location of plant structures; schematic flow diagram showing the flow through various plant units and for the various utility systems serving the plant processes; piping, including any arrangement for bypassing individual units; materials handled and direction

of flow through pipes; hydraulic profiles showing the flow of sewage, supernatant liquid and sludge; test borings; and groundwater elevations shall be provided.

3. Detail plans. Detail plans shall show the following, unless otherwise covered by the specifications or engineer's reports—location, dimensions and elevations of all existing and proposed plant facilities; elevation of high and low water level of the body of water to which the plant effluent is to be discharged; type, size, pertinent features and operating capacity of all pumps, blowers, motors and other mechanical devices; minimum, average and maximum hydraulic flow in profile; and adequate description of any other features pertinent to the design.

(7) Specifications. Complete technical specifications for the construction of sewers, sewage pumping stations, sewage treatment plants and all appurtenances shall accompany the plans. The specifications accompanying construction drawings shall include, but not be limited to, all construction information not shown on the drawings which is necessary to inform the builder in detail of the design requirements as to the quality of materials and workmanship and fabrication of the project and the type, size, strength, operating characteristics and rating of equipment; allowable infiltration; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping and jointing of pipe; electrical apparatus, wiring, instrumentation and meters; laboratory fixtures and equipment; operating tools; construction materials; special filter materials such as stone, sand, gravel or slag; miscellaneous appurtenances; chemicals when used; instructions for testing materials and equipment as necessary to meet design standards; and performance tests for the completed works and component units. It is suggested that these performance tests be conducted at design load conditions wherever practical.

(8) Revisions to Approved Plans. Any deviations from approved plans or specifications affecting capacity, flow, operation of units or point of discharge shall be approved in writing before such changes are made. Plans or specifications so revised should be submitted thereto as well in advance of any construction work which will be affected by the changes, to permit sufficient time for review and approval. Structural revisions or other minor changes not affecting capacities, flows or operation will be permitted during construction without approval. As-built plans clearly showing the alterations shall be submitted to the agency at the completion of the work.

(9) Operation During Construction. Specifications shall contain a program for keeping existing treatment plant units in operation during construction of plant additions. Should it be necessary to take plant units out of operation, a shutdown schedule which will minimize pollutional effects on the receiving stream shall be reviewed and approved in advance by the agency and shall be adhered to.

AUTHORITY: section 644.026, RSMo 1986. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.120 Design of Sewers

PURPOSE: The following criteria have been prepared as a guide for the design of sewers. This rule is to be used with rules 10 CSR 20-8.110—10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers Recommended Standards for Sewage Works and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.

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(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons per day ($85.4m^3$) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) Approval of Sewers. In general, the agency will approve plans for new systems, extensions to new areas or replacement sanitary sewers only when designed upon the separate plan, in which rainwater from roofs, streets and other areas and groundwater from foundation drains are excluded.

(4) Design Capacity. In general, sewer capacities should be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions, industrial parks, etc. Where future relief sewers are programmed, economic analysis of alternatives should accompany initial permit applications. In determining the required capacities of sanitary sewers, the following factors should be considered: maximum hourly domestic sewage flow; additional maximum sewage or waste flow from industrial plants; inflow and groundwater infiltration; topography of area; location of sewage treatment plant; depth of excavation; and pumping requirements. The basis of design for all sewer projects shall accompany the plan documents. More detailed computations may be required by the agency for critical projects.

(5) Design Flow.

(A) Per Capita Flow. New sewer systems shall be designed on the basis of an average daily per capita flow of sewage of not less than one hundred (100) gallons per day ($.38m^3$/day). This figure is assumed to cover normal infiltration but an additional allowance should be made where conditions are unfavorable. For existing sewer systems an additional per capita allowance shall be made where the average annual flow exceeds this value and immediate remedial measures are not proposed.

(B) Peak Design Flow. Sanitary sewers shall be designed on a peak design flow basis using one (1) of the following methods: the ratio of peak to average daily flow as determined from the quotient of eighteen (18) plus the square root of the population in thousands divided by four (4) plus the square root of population in thousands or values established from an infiltration/inflow study acceptable to the agency. Use of other values for peak design flow will be considered if justified on the basis of extensive documentation.

(C) Combined Sewer Interceptors. In addition to the requirements in subsection (5)(B) of this rule, interceptor sewers that will receive combined sewage shall have sufficient additional capacity to insure attainment of the appropriate state and federal water quality standards.

(6) Details of Design and Construction.

(A) Minimum Size. Gravity collector sewers conveying raw sewage shall be no less than eight inches (8") (20 cm) in diameter, except in unusual circumstances where smaller diameter pipe can be justified.

(B) Depth. In general, sewers should be sufficiently deep so as to receive sewage from basements and to prevent freezing and to protect them from superimposed loads. Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

(C) Slope.

1. All sewers shall be so designed and constructed to give mean velocities, when flowing full, of not less than two feet (2') per second (0.61m/s), based on Kutter's formula using an "n" value of 0.013. The following are the minimum slopes which should be provided; however, slopes greater than this are desirable:

Sewer Size	Minimum Slope in Feet Per 100 Feet (m/100 m)
8 in. (20 cm)	0.40
9 in. (23 cm)	0.33
10 in. (25 cm)	0.28
12 in. (30 cm)	0.22
14 in. (36 cm)	0.17
15 in. (38 cm)	0.15
16 in. (41 cm)	0.14
18 in. (46 cm)	0.12
21 in. (53 cm)	0.10
24 in. (61 cm)	0.08
27 in. (69 cm)	0.067
30 in. (76 cm)	0.058
36 in. (91 cm)	0.046

2. The pipe diameter and slope shall be selected to obtain the greatest practical velocities to minimize settling problems. Slopes slightly less than those required for the 2.0 feet per second (0.61m/s) velocity when flowing full may be permitted. Decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or greater and the velocity from partial flow determination will be 0.9 feet per second (27.4 cm/s) or greater based on design average flow. These reduced slopes may result in better flow characteristics at design flow than minimum slope in a larger pipe. Whenever the decreased slopes are selected, the design engineer must furnish with his/her report computations of the anticipated flow velocities of average and daily or weekly peak flow rates. The operating authority of the sewer system will give written assurance to the agency that any additional sewer maintenance required by reduced slopes will be provided.

3. Sewers shall be laid with uniform slope between manholes.

4. Where velocities greater than fifteen feet (15') per second (4.6m/s) are attained, special provision shall be made to protect against displacement by erosion and shock.

5. Sewers on twenty percent (20%) slope or greater shall be anchored securely with concrete anchors or equal, spaced as follows: not over thirty-six feet (36') (11m) center-to-center on grades twenty percent (20%) and up to thirty-five percent (35%); not over twenty-four feet (24') (7.3m) center-to-center on grades thirty-five percent (35%) and up to fifty percent (50%); and not over sixteen feet (16') (4.9m) center-to-center on grades fifty percent (50%) and over.

(D) Alignment. Sewers twenty-four inches (24") (61 cm) or less shall be laid with straight alignment between manholes. The alignment shall be checked by either using a laser beam or lamping.

(E) Changes in Pipe Size. When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation. Sewer extensions should be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension. The agency may require a schedule for future downstream sewer relief.

(F) Materials. Any generally accepted material for sewers will be given consideration but the material selected should be adapted to local conditions, such as character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion and similar problems. All sewers shall be designed to prevent damage from superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of the trench. Where necessary to withstand extraordinary superimposed loading, special bedding, concrete cradle or special construction may be used.

(G) Installation.

1. Standards. Installation specifications shall contain appropriate requirements based on the criteria, standards and requirements established by industry in its technical publications. Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping nor create excessive side fill pressures or ovalation of the pipe nor seriously impair flow capacity.

2. Trenching.

A. The width of the trench shall be ample to allow the pipe to be laid and jointed properly and to allow the backfill to be placed and compacted as needed. The trench sides shall be kept as nearly vertical as possible. When wider trenches are dug, appropriate bedding class and pipe strength shall be used.

B. Ledge rock, boulders and large stones shall be removed to provide a minimum clearance of four inches (4") (10 cm) below and on each side of all pipe.

3. Bedding.

A. Concrete or well-graded granular material (bedding classes A, B or C as described in ASTM C12-74 or WPCP MOP No. 9) shall be used for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

B. Concrete or well-graded granular material (bedding classes I, II or III as described in ASTM D2321-74) shall be used for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

4. Backfill.

A. Backfill shall be of a suitable material removed from excavation except where other material is specified. Debris, frozen material, large clods or stones, organic matter or other unstable materials shall not be used for backfill within two feet (2') (0.61 m) of the top of the pipe.

B. Backfill shall be placed in a manner as not to disturb the alignment of the pipe.

5. Deflection test.

A. Deflection tests shall be performed on all flexible pipe. The test shall be run not less than thirty (30) days after final backfill has been placed.

B. No pipe shall extend a deflection of five percent (5%).

C. If the deflection test is to be run using a rigid ball or mandrels, they shall have diameters equal to ninety-five percent (95%) of the inside diameter of the pipe and the tests shall be performed without mechanical pulling devices.

(H) Joints and Infiltration.

1. Joints. The installation of joints and the materials used shall be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

2. Leakage tests. Leakage tests shall be specified. This may include appropriate water or low pressure air testing. The leakage outward or inward (exfiltration or infiltration) shall not exceed two hundred (200) gallons per inch of pipe diameter per mile per day ($0.19m^3$/cm of pipe dia./km/day) for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of two feet (2') (0.61m). The air test, if used, as a minimum shall conform to the test procedure described in ASTM C-828-76T, entitled *Tentative Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines*. The testing methods selected should take into consideration the range in groundwater elevations projected and the situation during the test. For the purpose of leakage tests, manholes shall be considered pipe of equivalent diameter and shall be tested by an appropriate test method.

(7) Manholes.

(A) Location. Manholes shall be installed at the end of each line; at all changes in grade, size or alignment; at all intersections; and at distances not greater than four hundred feet (400') (120 m) for sewers fifteen inches (15") (38 cm) or less and five hundred feet (500') (150m) for sewers eighteen inches to thirty inches (18"—30") (46 cm—76 cm), except that distances up to six hundred feet (600') (180m) may be approved in cases where adequate modern cleaning equipment for such spacing is provided. Greater spacing may be permitted in larger sewers. Cleanouts may be used only for special conditions and shall not be substituted for manholes nor installed at the end of laterals greater than one hundred fifty feet (150') (46m) in length.

(B) Drop Type. A drop pipe should be provided for a sewer entering a manhole at an elevation of twenty-four inches (24") (61 cm) or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than twenty-four inches (24") (61 cm), the invert should be filleted to prevent solids deposition. Drop manholes should be constructed with outside drop connection. Inside drop connections (when necessary) shall be secured to the interior wall of the manhole and provide access for cleaning. Due to the unequal earth pressures that would result from the backfilling operation in the vicinity of the manhole, the entire outside drop connection shall be encased in concrete.

(C) Diameter. The minimum interior diameter of manholes shall be forty-two inches (42") (1.07m) on eight-inch (8") (20 cm) diameter gravity sewer lines and forty-eight inches (48") (1.22m) on all sewer lines larger than eight inches (8") (20 cm) in diameter. Larger diameter manholes are necessary for large diameter sewers in order to maintain structural integrity. A minimum access diameter of twenty-two inches (22") (56 cm) shall be provided.

(D) Flow Channel. The flow channel through manholes should be made to conform in shape and slope to that of the sewers.

(E) Watertightness. Manholes shall be of the precast concrete or poured in place concrete type. Manholes shall be waterproofed on the exterior. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place. Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.

(F) Electrical. Electrical equipment installed or used in manholes shall conform to 10 CSR 20-8.130(4)(C)5.

(8) Inverted Siphons. Inverted siphons should have not less than two (2) barrels, with a minimum pipe size of six inches (6") (15 cm) and shall be provided with necessary appurtenances for convenient flushing and maintenance; the manholes shall have adequate clearances for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second (0.92m/s) for average flows. The inlet and outlet details shall be arranged so that the normal flow is diverted to one (1) barrel and so that either barrel may be cut out-of-service for cleaning. The vertical alignment should permit cleaning and maintenance.

(9) Sewers in Relation to Streams.

(A) Location of Sewers on Streams.

1. Cover depth. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, the following cover requirements must be met: one foot (1') (0.3m) of cover is required where the sewer is located in rock; three feet (3') (0.9m) of cover is required in other material (in major streams, more than three feet (3') (0.9m) of cover may be required); in paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement. Less cover will be approved only if the proposed sewer crossing will not interfere with the future improvements to the stream channel. Reasons for requesting less cover should be given in the project proposal.

2. Horizontal location. Sewers located along streams shall be located outside of the stream bed and sufficiently removed therefrom to provide for future possible stream widening and to prevent pollution by siltation during construction.

3. Structures. The sewer outfalls, head walls, manholes, gateboxes or other structures shall be so located that they do not interfere with the free discharge of flood flows of the streams.

4. Alignment. Sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible and shall be free from change in grade. Sewer systems shall be designed to minimize the number of stream crossings.

(B) Construction.

1. Materials. Sewers entering or crossing streams shall be constructed of cast- or ductile-iron pipe with mechanical joints or shall be so otherwise constructed that they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel or other materials which will not cause siltation.

2. Siltation and erosion. Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams to provide adequate control of siltation and erosion. Specifications shall require that clean-up, grading, seeding, planting or restoration of all work areas shall begin immediately and exposed areas shall not remain unprotected for more than seven (7) days.

(10) Aerial Crossings. Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning and settlement. Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided

between above-ground and below-ground sewers. For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the fifty (50)-year flood.

(11) Protection of Water Supplies.

(A) Water Supply Interconnections. There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

(B) Relation to Water Works Structures. While no general statement can be made to cover all conditions, it is generally recognized that sewers shall meet the requirements of 10 CSR 60-2.010 with respect to minimum distances from public water supply wells or other water supply sources and structures.

(C) Relation to Water Mains.

1. Horizontal separation. Sewer mains shall be laid at least ten feet (10') (3.0m) horizontally from any existing or proposed water main. The distances shall be measured edge-to-edge. In cases where it is not practical to maintain a ten foot (10')-separation, the agency may allow deviation on a case-by-case basis, if supported by data from the design engineer. This deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one (1) side of the sewer at an elevation that the bottom of the water main is at least eighteen inches (18") (46 cm) above the top of the sewer.

2. Crossings. Sewers crossing water mains shall be laid to provide a minimum vertical distance of eighteen inches (18") (46 cm) between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. When a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

3. Special conditions. When it is impossible to obtain proper horizontal and vertical separation as stipulated previously, the sewer shall be designed and constructed equal to water pipe and shall be pressure tested to assure watertightness prior to backfilling.

AUTHORITY: section 644.026, RSMo Supp. 1993. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed May 17, 1994, effective Dec. 30, 1994.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.130 Sewage Pumping Stations

PURPOSE: The following criteria have been prepared as a guide for the design of sewage pumping stations. This rule is to be used with rules 10 CSR 20-8.110—10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers **Recommended Standards for Sewage Works** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons per day ($85.4m^3$) or less, see 10 CSR 20-8.020 for the requirements for those facilities.

(3) General.

(A) Flooding. Sewage pumping station structures and electrical and mechanical equipment shall be protected from physical damage by the one hundred (100)-year flood. Sewage pumping stations should remain fully operational and accessible during the twenty-five (25)-year flood.

(B) Accessibility. The pumping station shall be readily accessible by maintenance vehicles during all weather conditions. The facility should be located off the traffic way of streets and alleys.

(C) Grit. Where it is necessary to pump sewage prior to grit removal, the design of the wet well and pump station piping shall receive special consideration to avoid operational problems from the accumulation of grit.

(4) Design.

(A) Type. Sewage pumping stations should be of the wet/dry well type. Other types as set forth under sections (5) and (6) of this rule may be approved where circumstances justify their use.

(B) Structures.

1. Separation. Dry wells, including their superstructure, shall be completely separated from the wet well.

2. Equipment removal. Provision shall be made to facilitate removing pumps, motors and other mechanical and electrical equipment.

3. Access. Suitable and safe means of access shall be provided to dry wells and to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance. For built-in-place pump stations, a stairway with rest landings shall be provided at vertical intervals not to exceed twelve feet (12') (3.7m). For factory-built pump stations over fifteen feet (15') (4.6m) deep, a rigidly fixed landing shall be provided at vertical intervals not to exceed ten feet (10') (3.0m). Where a landing is used, a suitable and rigidly fixed barrier shall be provided to prevent an individual from falling past the intermediate landing to a lower level. Where approved by the agency, a manlift or elevator may be used in lieu of landings in a factory-built station, provided emergency access is included in the design. Reference should be made to local, state and federal safety codes and, if they are more stringent, they shall govern (also see 10 CSR 20-8.140(8)(F)).

4. Construction materials. Due consideration shall be given to the selection of materials because of the presence of hydrogen sulfide and other corrosive gases, greases, oils and other constituents frequently present in sewage.

(C) Pumps and Pneumatic Ejectors.

1. Multiple units. At least two (2) pumps or pneumatic ejectors shall be provided. A minimum of three (3) pumps should be provided for stations handling flows greater than one (1) mgd ($3800m^3/d$). If only two (2) units are provided, they should have the same capacity. Each shall be capable of handling flows in excess of the expected maximum flow. Where three (3) or more units are provided, they should be designed to fit actual flow conditions and must be of a capacity that with any one (1) unit out-of-service the remaining units will have capacity to handle maximum sewage flows.

2. Protection against clogging. Pumps handling combined sewage shall be preceded by readily accessible bar racks to protect the pumps from clogging or damage. Bar racks should have clear openings not exceeding two and one-half inches (2 1/2") (6.4 cm). Where a bar rack is provided, a mechanical hoist shall also be provided. Where the size of the installation warrants, mechanically cleaned and/or duplicate bar racks shall be provided. Pumps handling separate sanitary sewage from thirty inches (30") (76 cm) or larger diameter sewers shall be protected by bar racks meeting these requirements. Appropriate protection from clogging shall also be considered for small pumping stations.

3. Pump openings. Except where grinder pumps are used, pumps shall be capable of passing spheres of at least three inches (3") (7.6 cm) in diameter and pump suction and discharge piping shall be at least four inches (4") (10.2 cm) in diameter.

4. Priming. The pump shall be so placed that under normal operating conditions it will operate under a positive suction head, except as specified in section (5) of this rule.

5. Electrical equipment. Electrical systems and components (for example, motors, lights, cables, conduits, switchboxes, control circuits, etc.) in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, including raw sewage wet wells, shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location). In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each flexible cable shall be provided with watertight seal and separate strain relief. A fused disconnect switch located above ground shall be provided for all pumping stations. When the equipment is exposed to weather, it shall meet the requirements of weather proof equipment (NEMA 3R).

6. Intake. Each pump should have an additional individual intake. Wet well design should be such as to avoid turbulence near the intake. Intake piping should be as straight and short as possible.

7. Dry well de-watering. A separate sump pump equipped with dual check valves shall be provided in the dry wells to remove leakage or drainage with the discharge located as high as possible. A connection to the pump suction is also recommended as an auxiliary feature. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump.

8. Pumping rates. The pumps and controls of main pumping stations and especially pumping stations pumping to the treatment works or operated as part of the treatment works should be selected to operate at varying delivery rates to permit discharging sewage at approximately its rate of delivery to the pump station. Design pumping rates should be established in accordance with 10 CSR 20-8.120(5) or 10 CSR 20-8.140(5)(C)1. as appropriate.

(D) Controls.

1. Type. Control systems shall be of the air bubbler type, the encapsulated float type or the flow measuring type. Float tube control systems on existing stations being upgraded may be approved. The electrical equipment shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location).

2. Location. The control system shall be located away from the turbulence of incoming flow and pump suction.

3. Alternation. In small stations, provisions should be made to automatically alternate the pumps in use.

(E) Valves.

1. Suitable shutoff valves shall be placed on the suction line of each pump except on submersible and vacuum primed pumps.

2. Suitable shutoff and check valves shall be placed on the discharge line of each pump. The check valve shall be located between the shutoff valve and the pump. Check valves shall be suitable for the material being handled. Check valves shall not be placed on the vertical portion of discharge piping. Valves shall be capable of withstanding normal pressure and water hammer. Where limited pump backspin will not damage the pump and low discharge head conditions exist, short individual force mains for each pump may be considered in lieu of discharge valves.

3. Valves shall not be located in the wet well.

(F) Wet Wells.

1. Divided wells. Consideration should be given to dividing the wet well into multiple sections, properly interconnected, to facilitate repairs and cleaning.

2. Size. The wet well size and control setting shall be appropriate to avoid heat buildup in the pump motor due to frequent starting and to avoid septic conditions due to excessive detention time.

3. Floor slope. The wet well floor shall have a minimum slope of one to one (1:1) to the hopper bottom. The horizontal area of the hopper bottom shall not be greater than necessary for proper installation and function of the inlet.

(G) Ventilation. Adequate ventilation shall be provided for all pump stations. Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well if screens or mechanical equipment requiring maintenance or inspection are located in the wet well. There shall be no interconnection between the wet well and dry well ventilation systems. In pits over fifteen feet (15') (4.6m) deep, multiple inlets and outlets are desirable. Dampers should not be used on exhaust or fresh air ducts and fine screens or other obstructions in air ducts should be avoided to prevent clogging. Switches for operation of ventilation equipment should be marked and located conveniently. All intermittently operated ventilating equipment shall be interconnected with the respective pit lighting system. Consideration should be given also to automatic controls where intermittent operation is used. The fan wheel should be fabricated from non-sparking material. Consideration should be given to installation of automatic heating and/or dehumidification equipment.

1. Wet wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least twelve (12) complete air changes per hour, if intermittent, at least thirty (30) complete air changes per hour. Air shall be forced into the wet well rather than exhausted from the wet well.

2. Dry wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least six (6) complete air changes per hour, if intermittent, at least thirty (30) complete air changes per hour.

(H) Flow Measurement. Suitable devices for measuring sewage flow should be considered at all pumping stations.

(I) Water Supply. There shall be no physical connection between any potable water supply and a sewage pumping station which under any conditions might cause contamination of the potable water supply. If a potable water supply is brought to the station, it should comply with conditions stipulated under 10 CSR 20-8.140(8)(B).

(5) Suction Lift Pumps. Suction lift pumps shall be of the self priming or vacuum priming type and shall meet the applicable requirements under section (4) of this rule. Suction lift pump stations using dynamic suction lifts exceeding the limits outlined in the following subsections may be approved by the agency upon submission of factory certification of pump performance and detail calculations indicating satisfactory performance under the proposed operating conditions. Detail calculations must include static suction lift as measured from "lead pump off" elevation to center line of pump suction, friction and other hydraulic losses of the suction piping, vapor pressure of the liquid, altitude correction, required net positive suction head and a safety factor of at least six feet (6') (1.8m). The pump equipment compartment shall be above grade or offset and shall be effectively isolated from the wet well to prevent the humid and corrosive sewer atmosphere from entering the equipment compartment. Wet well access shall not be through the equipment compartment. Valving shall not be located in the wet well.

(A) Self-Priming Pumps. Self-priming pumps shall be capable of rapid priming and repriming at the "lead pump on" elevation. This self-priming and repriming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed twenty-five feet (25') (7.6m) in total length. Priming lift at the "lead pump on" elevation shall include a safety factor of at least four feet (4') (1.2m) from the maximum allowable priming lift for the specific equipment at design operating conditions. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed twenty-two feet (22') (6.7m).

(B) Vacuum Priming Pumps. Vacuum priming pump stations shall be equipped with dual vacuum pumps capable of automatically and completely removing air from the suction lift pump. The vacuum pumps shall be adequately protected from damage due to sewage. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed twenty-two feet (22") (6.7m).

(6) Submersible Pump Stations. Submersible pump stations shall meet the applicable requirements under section (4) of this rule, except as modified in this section.

(A) Construction. Submersible pumps and motors shall be designed specifically for raw sewage use, including totally submerged operation during a portion of each pumping cycle. An effective method to detect shaft seal failure or potential seal failure shall be provided and the motor shall be of squirrel-cage type design without brushes or other arc-producing mechanisms.

(B) Pump Removal. Submersible pumps shall be readily removable and replaceable without de-watering the wet well or disconnecting any piping in the wet well.

(C) Electrical.

1. Power supply and control. Electrical supply and control circuits shall be designed to allow disconnection at a junction box located or accessible from outside the wet well. Terminals and connectors shall be protected from corrosion by location outside of the wet well or by watertight seals.

2. Controls. The motor control center shall be located outside the wet well and be protected by a conduit seal to prevent the atmosphere in the wet well from gaining access to the control center. The seal shall be located so that the motor may be removed and electrically disconnected without disturbing the seal.

3. Power cord. Pump motor power cords shall be designed for flexibility and serviceability under conditions of extra hard usage and shall meet the requirements of the Mine Safety and Health Administration for trailing cables. Ground fault interruption protection shall be used to de-energize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings shall be corrosion resistant and be constructed in a manner to prevent the entry of moisture into the cable, shall be provided with strain relief appurtenances and shall be designed to facilitate field connecting.

(D) Valves. Valves required under subsection (4)(E) of this rule shall be located in a separate valve pit. Accumulated water shall be drained to the wet well or to the soil. If the valve pit is drained to the wet well, an effective method shall be provided to prevent sewage from entering the pit during surcharged wet well conditions.

(7) Alarm Systems. Alarm systems shall be provided for pumping stations. The alarm shall be activated in cases of power failure, pump failure, use of the lag pump, unauthorized entry or any cause of pump station malfunction. Pumping station alarms shall be telemetered, including identification of the alarm condition, to a municipal facility that is manned twenty-four (24) hours a day. If such a facility is not available and twenty-four (24)-hour holding capacity is not provided, the alarm shall be telemetered to city offices during normal working hours and to the home of the person(s) responsible in charge of the lift station during off-duty hours. Audiovisual alarm systems with a self-contained power supply may be acceptable in some cases in lieu of the telemetering system outlined in this section, depending upon location, station holding capacity and inspection frequency.

(8) Emergency Operation. Pumping stations and collection systems shall be designed to prevent or minimize bypassing of raw sewage. For use during possible periods of extensive power outages, mandatory power reductions or uncontrolled storm events, consideration should be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency power generation in order to prevent backup of sewage into basements, or other discharges which may cause severe adverse impacts on public interests, including public health and property damage. Where a controlled diversion is utilized, consideration shall also be given to the installation of storage-detention tanks or basins, which will be made to drain to the station wet well. Where overflows affect public water supplies, shellfish production or waters used for culinary or food processing purposes, a storage-detention basin or tank, shall be provided having two (2)-hour detention capacity at the anticipated overflow rate.

(A) Overflow Prevention Methods. A satisfactory method shall be provided to prevent or minimize overflows. The following methods should be evaluated on an individual basis. The choice should be based on least cost and least operational problems of the methods providing an acceptable degree of reliability. The methods are—

1. Storage capacity including trunk sewers for retention of wet weather flows. Storage basins must be designed to drain back into the wet well or collection system after the flow recedes;

2. An in-place or portable pump, driven by an internal combustion engine meeting the requirements of subsection (8)(B) of this rule, capable of pumping from the wet well to the discharge side of the station; and

3. Two (2) independent public utility sources or engine-driven generating equipment meeting the requirements of subsection (8)(B) of this rule.

(B) Equipment Requirements.

1. General. The following general requirements shall apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives or electrical generating equipment.

A. Engine protection. The engine must be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is planned, protective equipment shall be capable of shutting down the engine and activating an alarm on-site and as provided in section (7) of this rule. Protective equipment shall monitor for conditions of low oil pressure and overheating, except oil pressure monitoring will not be required for engines with splash lubrication.

B. Size. The engine shall have adequate rated power to start and continuously operate all connected loads.

C. Fuel type. Reliability and ease of starting, especially during cold weather conditions should be considered in the selection of the type of fuel.

D. Engine ventilation. The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.

E. Routine start-up. All emergency equipment shall be provided with instructions indicating the need for regular starting and running of the units at full loads.

F. Protection of equipment. Emergency equipment shall be protected from damage at the restoration of regular electrical power.

2. Engine-driven pumping equipment. Where permanently installed or portable engine-driven pumps are used, the following requirements in addition to general requirements shall apply:

A. Pumping capacity. Engine-driven pump(s) shall meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift if applicable;

B. Operation. The engine and pump shall be equipped to provide automatic start-up and operation of pumping equipment. Provisions shall also be made for manual start-up. Where manual start-up and operation is justified, storage capacity and alarm system must meet the requirements of subparagraph (8)(B)2.C. of this rule; and

C. Portable pumping systems. Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity to allow time for detection of pump station failure and transportation and hookup of the portable equipment shall be provided. A riser from the force main with quick-connect coupling and appropriate valving shall be provided to hookup portable pumps.

3. Engine-driven generating equipment. Where permanently installed or portable engine-driven generating equipment is used, the following requirements in addition to general requirements shall apply:

A. Generating capacity. Generating unit size shall be adequate to provide power for pump motor starting current and for lighting, ventilation and other auxiliary equipment necessary for safety and proper operation of the lift station. The operation of only one (1) pump during periods of auxiliary power supply must be justified. Justification may be made on the basis of maximum anticipated flows relative to single pump capacity, anticipated length of power outage and storage capacity. Special sequencing controls shall be provided to start pump motors unless the generating equipment has capacity to start all pumps simultaneously with auxiliary equipment operating;

B. Operation. Provisions shall be made for automatic and manual start-up and load transfer. The generator must be protected from operating conditions that would result in damage to equipment. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity and alarm system must meet the requirements of subparagraph (8)(B)3.C. of this rule; and

C. Portable generating equipment. Where portable generating equipment or manual transfer is provided, sufficient storage capacity to allow time for detection of pump station failure and transportation and connection of generating equipment shall be provided. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.

(9) Grinder Pumps in Pressure Sewer Systems. A pressure sewer system is defined as two (2) or more grinder pump units at different locations discharging into a common force main. Grinder pump units and pressure systems are not to be used in lieu of conventional gravity collection systems; however, grinder pumps may be used where it is not feasible to provide conventional gravity sewer service, such as where the topography makes it difficult for the users to be served by a conventional system, groundwater conditions make construction and maintenance of a conventional system difficult or excessive rock excavation makes a conventional system impractical. The operating authority shall be responsible for the entire system which shall include the force mains, grinder pump units and appurtenances.

(A) Pump Openings. The grinder unit must be capable of reducing any material which enters the grinder unit to a size that the materials will pass through the pump unit and force main without plugging or clogging. No screens or other devices requiring regular maintenance may be used to keep trashy or stringy material out of the grinder pump or force main. This requirement shall be in lieu of the requirements in paragraph (4)(C)3. of this rule.

(B) Storage Capacity. The minimum storage capacity of the grinder pump unit shall be fifty (50) gallons (189 l). The unit shall be capable of accommodating normal peak flows for periods of eight to twelve (8—12) hours.

(C) Alarm System. For grinder pump units serving a single home, an audiovisual alarm capable of alerting the resident and operating personnel in the area may be used in lieu of the alarm system specified in section (7) of this rule.

(D) Valves. A gate valve must be provided on the service line near the common force main.

(E) Force Main Velocity. The velocity shall meet the requirements of subsection (11)(A) of this rule based on the most probable number of pump units expected to operate simultaneously or on some other acceptable method of computing the peak pumpage rate.

(F) Cleaning. Consideration should be given to providing a suitable method of cleaning the force main whenever the velocity in the force main may be less than two feet (2') per second (0.61m/s) before ultimate development is reached.

(G) Electrical. Units must be serviceable and replaceable under wet conditions without electrical hazard to repair personnel. Electrical equipment shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location).

(H) Standby Units. One (1) standby unit for each fifty (50) units or fraction thereof must be provided for each model installed.

(I) Service Interruptions. Provisions shall be made to avoid interruption of service due to mechanical or power failure by providing standby power, storage capacity or interconnection with another disposal system.

(10) Instructions and Equipment. Sewage pumping stations and their operators should be supplied with a complete set of operational

instructions, including emergency procedures, maintenance schedules, special tools and spare parts as may be necessary.

(11) Force Mains.

(A) Velocity. At design average flow a velocity of at least two feet (2') per second (0.61m/s) shall be maintained.

(B) Air Relief Valve. An air relief valve shall be placed at high points in the force main to prevent air locking. When accumulation of air or decomposition gases are likely, an automatic air relief valve suitable for use on sewage force mains shall be used.

(C) Termination. Force mains should enter the gravity sewer system at a point not more than two feet (2") (30 cm) above the flow line of the receiving manhole.

(D) Design Pressure. The force main and fittings including reaction blocking shall be designed to withstand normal pressure and pressure surges (water hammer).

(E) Special Construction. Force main construction near streams or used for aerial crossings shall meet applicable requirements of 10 CSR 20-8.120(9) and (10).

(F) Design Friction Losses. Friction losses through force mains shall be based on the Hazen and Williams formula or other acceptable method. When the Hazen and Williams formula is used, the following values for "C" shall be used for design; unlined iron or steel—one hundred (100) and all other—one hundred twenty (120). When initially installed, force mains will have a significantly higher "C" factor. The higher "C" factor should be considered only in calculating maximum power requirements.

(G) Separation from Water Mains. There shall be at least a ten-foot (10') (3.0m) horizontal separation between water mains and sanitary sewer force mains. Force mains crossing water mains shall be laid to provide a minimum vertical distance of eighteen inches (18") (46 cm) between the outside of the force main and the outside of the water main. This shall be the case where the water main is either above or below the force main. At crossings, one (1) full length of water pipe shall be located so both joints will be as far from the force main as possible. Special structural support for the water main and force main may be required.

(H) Identification of Force Mains. Where force mains are constructed of material which might cause the force main to be confused with potable water mains, the force main should be appropriately identified.

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.140 Sewage Treatment Works

*PURPOSE: The following criteria have been prepared as a guide for the general design requirements for sewage treatment works. This rule is to be used with rules 10 CSR 20-8.110—10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers **Recommended Standards for Sewage Works** and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred gallons per day (22,500 gpd) (85.4 m^3) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) Plant Location. The following items shall be considered when selecting a plant site: proximity to residential areas; direction of prevailing winds; accessibility by all-weather roads; area available for expansion; local zoning requirements; local soil characteristics, geology, hydrology and topography available to minimize pumping; access to receiving stream; downstream uses of the receiving stream and compatibility of treatment process with the present and planned future land use, including noise, potential odors, air quality and anticipated sludge processing and disposal techniques. Where a site must be used which is critical with respect to these items, appropriate measures shall be taken to minimize adverse impacts.

(A) Flood Protection. The treatment works structures, electrical and mechanical equipment shall be protected from physical damage by the one hundred (100)-year flood. Treatment works should remain fully operational and accessible during the twenty-five (25)-year flood. This applies to new construction and to existing facilities undergoing major modification.

(4) Quality of Effluent. The required degree of wastewater treatment shall be based on 10 CSR 20-7.015, Effluent Regulations and 10 CSR 20-7.031, Water Quality Standards.

(5) Design.

(A) Type of Treatment. As a minimum, the following items shall be considered in the selection of the type of treatment: present and future effluent requirements; location of and local topography of the plant site; space available for future plant construction; the effects of industrial wastes likely to be encountered; ultimate disposal of sludge; system capital costs; system operating and maintenance costs, including basic energy requirements; process complexity governing operating personnel requirements; and environmental impact on present and future adjacent land use.

(B) Required Engineering Data for New Process Evaluation. The policy of the agency is to encourage rather than obstruct the development of any methods or equipment for treatment of wastewater. The lack of inclusion in these standards of some types of wastewater treatment processes or equipment should not be construed as precluding their use. The agency may approve other types of wastewater treatment processes and equipment under the following conditions: the operational reliability and effectiveness of the process or device shall have been demonstrated with a suitably sized prototype unit operating at its design load conditions to the extent required by the agency; the agency may require monitoring observations, including test results and engineering evaluations, demonstrating the efficiency of the processes, detailed description of the test methods; testing, including appropriately composited samples, under various ranges of strength and flow rates (including diurnal) and waste temperature over a sufficient length of time to demonstrate performance under climatic and other conditions which may be encountered in the area of the proposed installations and other appropriate information; the agency may require that appropriate testing be conducted and evaluations be made under the supervision of a competent process engineer other than those employed by the manufacturer or developer.

(C) Design Loads.

1. Hydraulic design.

A. New systems.

(I) Undeveloped areas. The design for sewage treatment plants to serve new sewerage systems being built in currently undeveloped areas shall be based on an average daily flow of one hundred (100) gallons per capita (378 l/cap), unless water use data or other justification upon which to better estimate flow is provided.

(II) Existing developed areas. Consideration shall be given in the designs for sewage treatment plants to serve a new sewerage system for a municipality or sewer district for higher flow rates if a large percentage of older buildings are likely to contribute significant infiltration/inflow to the new sanitary sewer system through basement floor drains.

B. Existing systems. Where there is an existing system, the volume and strength of existing flows shall be determined. The determination shall include both dry weather and wet weather conditions. Samples shall be taken and composited so as to be accurately representative of the strength of the wastewater. At least one (1) year's flow data should be taken as the basis for the preparation of hydrographs for analysis to determine the following types of flow conditions of the system: the annual average daily flow—as determined by averaging flows over one (1) year, exclusive of inflow due to rainfall; the minimum daily flow—as determined by observing twenty-four (24)-hour flows during dry weather (low rainfall period) when infiltration/inflow are at a minimum; wet weather peak flows—as determined by observing twenty-four (24)-hour flows during a period of one (1) year when infiltration/inflow are at a maximum; wet weather flows of seven (7)-day duration—as determined by observing for a period of one (1) year the daily flows during the immediate seven (7)-day period following rainfall sufficient to cause ground surface runoff; peak hourly flows—as determined by observing the maximum hydraulic load to the plant; and industrial waste flows—as determined by flow data, including water use records, for each of the industries tributary to the sewer system. The plant design flow selected shall meet the appropriate effluent and water quality standards in 10 CSR 20-7.015 and 10 CSR 20-7.031.

C. Flow equalization. Facilities for the equalization of flows and organic shock load shall be considered at all plants which are critically affected by surge loadings. The sizing of the flow equalization facilities should be based on data obtained from paragraph (5)(C)1. of this rule and 10 CSR 20-8.120(5)(B).

2. Organic design.

A. New system minimum design. Domestic waste treatment design shall be on the basis of at least 0.17 pounds (0.08 kg) of biochemical oxygen demand (BOD) per capita per day and 0.20 pounds (0.09 kg) of suspended solids per capita per day, unless information is submitted to justify alternate designs; when garbage grinders are used in areas tributary to a domestic treatment plant, the design basis should be increased to 0.22 pounds (0.10 kg) of BOD per capita per day and 0.25 pounds (0.11 kg) of suspended solids per capita per day; domestic waste treatment plants that will receive industrial wastewater flows shall be designed to include these industrial waste loads.

B. Existing systems. When an existing treatment works is to be upgraded or expanded, the organic design shall be based upon the actual strength of the wastewater as determined from the measurements taken in accordance with subparagraph (5)(C)1.B. of this rule, with an appropriate increment for growth.

3. Shock effects. The shock effects of high concentrations and diurnal peaks for short periods of time on the treatment process, particularly for small treatment plants, shall be considered.

4. Design by analogy. Data from similar municipalities may be utilized in the case of new systems; however, thorough investigation that is adequately documented shall be provided to the agency to establish the reliability and applicability of the data.

(D) Conduits. All piping and channels should be designed to carry the maximum expected flows. The incoming sewer should be designed for unrestricted flow. Bottom corners of the channels must be filleted. Conduits shall be designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates should be placed in the channels to seal off unused sections which might accumulate solids. The use of shear gates or stop planks is permitted where they can be used in place of gate valves or sluice gates. Noncorrosive materials shall be used for these control gates.

(E) Arrangement of Units. Component parts of the plant should be arranged for greatest operating and maintenance convenience, flexibility, economy, continuity of maximum effluent quality so as to facilitate installation of future units.

(F) Flow Division Control. Flow division control facilities shall be provided as necessary to insure organic and hydraulic loading control to plant process units and shall be designed for easy operator access, change, observation and maintenance. Appropriate flow measurement shall be incorporated in the flow division control design.

(6) Plant Details.

(A) Installation of Mechanical Equipment. The specifications should be so written that the installation and initial operation of major items of mechanical equipment will be supervised by a representative of the manufacturer.

(B) Unit Isolation. Properly located and arranged structures and piping shall be provided so that each unit of the plant can be removed from service independently. The design shall facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode.

1. Continuity during construction. Final plan documents shall include construction requirements as deemed necessary by the agency to avoid unacceptable temporary water quality degradation.

(C) Drains. Means shall be provided to dewater each unit to an appropriate point in the process. Due consideration shall be given to the possible need for hydrostatic pressure relief devices to prevent flotation of structures. Pipes subject to clogging shall be provided with means for mechanical cleaning or flushing.

(D) Construction Materials. Due consideration should be given to the selection of materials which are to be used in sewage treatment works because of the possible presence of hydrogen sulfide and other corrosive gases, greases, oils or similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action.

(E) Painting. The use of paints containing lead or mercury should be avoided. In order to facilitate identification of piping, particularly in the large plants, it is suggested that different lines be color coded. The following color scheme is recommended for purposes of standardization: sludge line—brown; gas line—orange; potable water line—blue; chlorine line—yellow; sewage line—gray; compressed air line—green; and water lines for heating digesters or buildings—blue with a six inch (6") (15 cm) red band spaced thirty inches (30") (76 cm) apart. The contents shall be stenciled on the piping in contrasting color.

(F) Operating Equipment. A complete outfit of tools, accessories and spare parts necessary for the plant operator's use shall be provided. Readily accessible storage space and workbench facilities shall be provided and consideration be given to provision of a garage storage area for large equipment, maintenance and repair.

(G) Erosion Control During Construction. Effective site erosion control shall be provided during construction.

(H) Grading and Landscaping. Upon completion of the plant, the ground should be graded. Concrete or gravel walkways should be provided for access to all units. Where possible, steep slopes should be avoided to prevent erosion. Surface water shall not be permitted to drain into any unit. Particular care shall be taken to protect trickling filter beds, sludge beds and intermittent sand filters from stormwater runoff. Provision should be made for landscaping, particularly when a plant must be located near residential areas.

(7) Plant Outfalls.

(A) Entrance Impact Control. The outfall sewer shall be designed to discharge to the receiving stream in a manner acceptable to the agency. Consideration should be given in each case to the following: preference for free fall or submerged discharge at the site selected; utilization of cascade aeration of effluent discharge to increase dissolved oxygen; limited or complete across stream dispersion as needed to protect aquatic life movement and growth in the immediate reaches of the receiving stream; appropriate effluent sampling in accordance with subsection (7)(C) of this rule.

(B) Protection and Maintenance. The outfall sewer shall be so constructed and protected against the effects of flood water, ice or other hazards as to reasonably insure its structural stability and freedom from stoppage. A manhole should be provided at the shore end of all gravity sewers extending into the receiving waters. Hazards to navigation shall be considered in designing outfall sewers.

(C) Sampling Provisions. All outfalls shall be designed so that a sample of the effluent can be obtained at a point after the final treatment process and before discharge to or mixing with the receiving waters.

(8) Essential Facilities.

(A) Emergency Power Facilities. All plants shall be provided with an alternate source of electric power to allow continuity of operation during power failures, except as noted in this subsection. Methods of providing alternates include the connection of at least two (2) independent public utility sources, such as substations; a power line from each substation is recommended and will be required unless, documentation is received and approved by the agency verifying that duplicate line is not necessary to minimize water quality violations; portable or inplace internal combustion engine equipment which will generate electrical or mechanical energy; and portable pumping equipment when only emergency pumping is required.

1. Standby generating capacity normally is not required for aeration equipment used in the activated sludge process. In cases where a history of long-term (four (4) hours or more) power outages have occurred, auxiliary power for minimum aeration of the activated sludge will be required. Full power generating capacity may be required by the agency on certain stream segments.

2. Continuous disinfection, where required, shall be provided during all power outages.

(B) Water Supply.

1. General. An adequate supply of potable water under pressure should be provided for use in the laboratory and for general cleanliness around the plant. No piping or other connections shall exist in any part of the treatment works which, under any conditions, might cause the contamination of a potable water supply. The chemical quality should be checked for suitability for its intended uses, such as heat exchangers, chlorinators, etc.

2. Direct connections. Potable water from a municipal or separate supply may be used directly at points above grade for the following hot and cold supplies: lavatory; water closet; laboratory sink (with vacuum breaker); shower; drinking fountain; eye wash fountain; and safety shower. Hot water for any of these units shall not be taken directly from a boiler used for supplying hot water to a sludge heat exchanger or digester heating coils.

3. Indirect connections. A reduced pressure backflow preventer or a break tank shall be used to isolate the potable system from all other plant uses other than those listed in paragraph (8)(B)2. of this rule. Where permanent connections are to be made to uses other than those listed in paragraph (8)(B)2. of this rule, a break tank shall be used. Where a break tank is used, water shall be discharged to the break tank through an air-gap at least six inches (6") above the maximum flood line, ground level or the spill line of the tank, whichever is higher. Backflow preventers shall be located above the maximum flood line or ground level. A sign shall be permanently posted at every hose bib, faucet, hydrant or sill cock located on the water system beyond the break tank or backflow preventer to indicate that the water is not safe for drinking.

4. Separate potable water supply. Where it is not possible to provide potable water from a public water supply, a separate well may be provided. Location and construction of the well should comply with requirements of 10 CSR 60-2.010. Requirements governing the use of the supply are those contained in paragraphs (8)(B)2. and 3. of this rule.

5. Separate nonpotable water supply. Where a separate nonpotable water supply is to be provided, a break tank will not be necessary, but all system outlets shall be posted with a permanent sign indicating the water is not safe for drinking.

(C) Sanitary Facilities. Toilet, shower, lavatory and locker facilities should be provided in sufficient numbers and convenient locations to serve the expected plant personnel.

(D) Laboratory. All treatment works shall include a laboratory for making the necessary analytical determinations and operating control tests, except in individual situations where other arrangements are approved by the agency. The laboratory shall have sufficient size, bench space, equipment and supplies to perform all self-monitoring analytical work required by discharge permits and to perform the process control tests necessary for good management of each treatment process included in the design. The facilities and supplies necessary to perform analytical work to support industrial waste control programs will normally be included in the same laboratory. The laboratory size and arrangement must be sufficiently flexible and adaptable to accomplish these assignments. The layout should consider future needs for expansion in the event that more analytical work is needed.

1. Location and space. The laboratory should be located on ground level, easily accessible to all sampling points, with environmental control as an important consideration. It shall be located away from vibrating machinery or equipment which might have

adverse effects on the performance of laboratory instruments or the analyst or design or to prevent adverse effects from vibration. A minimum of four hundred (400) square feet ($37m^3$) of floor space should be allocated for the laboratory. If more than two (2) persons will be working in the laboratory at any given time, one hundred (100) square feet ($9.3m^3$) of additional space should be provided for each additional person. Bench top working surface should occupy at least thirty-five percent (35%) of the total floor space. Minimum ceiling height should be eight feet six inches (8'6") (2m). If possible this height should be increased to provide for installation of wall-mounted water stills, distillation racks and other equipment with extended height requirements.

2. Materials.

A. Ceilings. Acoustical tile should be used for ceiling except in high humidity areas where they should be constructed of plaster.

B. Walls. For easy maintenance and a pleasant working environment, light colored ceramic tile should be used from floor to ceiling for all interior walls.

C. Floors. Floor surfaces should be either vinyl asbestos or rubber, fire-resistant and highly resistant to acids, alkalies, solvents and salts.

D. Doors. Two (2) exit doors should be located to permit a straight egress from the laboratory preferably at least one (1) to outside the building. Panic hardware should be used. They should have large glass windows for easy visibility of approaching or departing personnel. Automatic door closers should be installed; swinging doors should not be used. Flush hardware should be provided doors if cart traffic is anticipated. Kick plates are also recommended.

3. Cabinets and bench tops. Wall hung cabinets are useful for dust-free storage of instruments and glassware. Units with sliding doors are preferable. They should be hung so the top shelf is easily accessible to the analyst. Thirty inches (30") (76 cm) from the bench top is recommended. One (1) or more cupboard style base cabinets should be provided for storing large items; however, drawer units are preferred for the remaining cabinets. Drawers should slide out so that entire contents are easily visible. They should be provided with rubber bumpers and with stops which prevent accidental removal. Drawers should be supported on ball bearings or nylon rollers which pull easily in adjustable steel channels. All metal drawer fronts should be of double wall construction. All cabinet shelving should be acid resistant and adjustable from inside the cabinet. Water, gas, air and vacuum service fixtures; traps, strainers, overflows, plugs and tailpieces; and all electrical service fixtures shall be supplied with the laboratory furniture. Generally, bench top height should be thirty-six inches (36") (91 cm). However, areas to be used exclusively for sit-down type operations should be thirty inches (30") (76 cm) high and include knee hole space. One-inch (1") (2.54 cm) overhangs and drip grooves should be provided to keep liquid spills from running along the face of the cabinet. Tops should be furnished in large sections one and one-fourth inches (1 1/4") (3.18 cm) thick. They should be field joined into a continuous surface with acid, alkali and solvent resistant cements which are at least as strong as the material of which the top is made.

4. Hoods. Fume hoods to promote safety and canopy hoods over heat releasing equipment shall be installed.

A. Fume hoods.

(I) Location. Fume hoods should be located where air disturbance at the face of the hood is minimal. Air disturbance may be created by persons walking past the hood, supply in diffusers, drafts from opening or closing a door, etc. Safety factors should be considered in locating a hood. If a hood is situated near a doorway, a secondary means of egress must be provided. Bench surfaces should be available next to the hood so that chemicals need not be carried long distances.

(II) Design and materials. The selection of fume hoods, their design and materials of construction must be made considering the variety of analytical work to be performed and the characteristics of the fumes, chemicals, gases or vapors that will or may be released by the activities therein. Special design and construction is necessary if perchloric acid use is anticipated. Consideration should be given for providing more than one (1) fume hood to minimize potential hazardous conditions throughout the laboratory. Fume hoods are not appropriate for operation of heat releasing equipment, that does not contribute to hazards, unless they are provided in addition to those needed to perform hazardous tasks.

(III) Fixtures. A cup sink should be provided inside each fume hood. All switches, electrical outlets, utility and baffle adjustment handles should be located outside the hood. Light fixtures should be explosion proof.

(IV) Exhaust. Twenty-four (24)-hour continuous exhaust capability should be provided. Exhaust fans should be explosion proof. Exhaust velocities should be checked when fume hoods are installed.

(V) Alarms. A buzzer for indicating exhaust fan failure and a static pressure gauge should be placed in the exhaust duct. A high temperature sensing device located inside the hood should be connected to the buzzer.

(VI) Canopy hoods. Canopy hoods should be installed over the bench top areas where hot plate, steam bath or other heating equipment or heat releasing instruments are used. The canopies should be constructed of steel, plastic or equivalent material and finished with enamel to blend with other laboratory furnishings.

5. Sinks. The laboratory shall be equipped with at least one (1) double-wall sink with drainboards. Additional sinks should be provided in separate work areas as needed and identified for the use intended. Sinks should be made of epoxy resin or plastic material with all appropriate characteristics for laboratory applications. Waste openings should be located toward the back so that a standing overflow will not interfere. All water fixtures on which hoses may be used should be provided with reduced zone pressure backflow preventers to prevent contamination of water lines. The sinks should be constructed of material highly resistant to acids, alkalies, solvents and salts, should be abrasion and heat resistant, nonabsorbent and light in weight. Traps should be made of glass, plastic or lead and easily accessible for cleaning.

6. Ventilation and lighting. Laboratories should be separately air conditioned with external air supply for one hundred percent (100%) makeup volume. In addition, separate exhaust ventilation should be provided. Ventilation outlet locations should be remote from ventilation inlets. Good lighting, free from shadows, is important for reading dials, meniscuses, etc., in the laboratory.

7. Gas and vacuum. Natural gas should be supplied to the laboratory. Digester gas should not be used. An adequately sized line source of vacuum should be provided with outlets available throughout the laboratory.

8. Balance and table. An analytical balance of the automatic, digital readout, single pan 0.1 milligram sensitivity type shall be provided. A heavy special design balance table which will minimize vibration of the balance shall be provided. It shall be located as remote as possible from windows, doors or other sources of drafts or air movements, so as to minimize undesirable impacts from these sources upon the balance.

9. Equipment, supplies and reagents. The laboratory shall be provided with all of the equipment, supplies and reagents that are needed to carry out all of the facility's analytical testing requirements. Discharge permit requirements, process control requirements

and industrial waste monitoring requirements should be considered when specifying equipment needs.

(E) Floor Slope. Floor surfaces shall be sloped adequately to a point of drainage.

(F) Stairways. Stairways shall be installed wherever possible in lieu of ladders. Spiral or winding stairs are permitted only for secondary access where dual means of egress are provided. Stairways shall have slopes between fifty degrees (50°) and thirty degrees (30°) (preferably nearer the latter) from the horizontal to facilitate carrying samples, tools, etc. Each tread and riser shall be of uniform dimension in each flight. Minimum tread run shall not be less than eight inches (8") (20.3 cm). The sum of the tread run and riser shall not be less than seventeen inches (17") (43 cm) nor more than eighteen inches (18") (46 cm). A flight of stairs shall consist of not more than a twelve-foot (12') (3.7m) continuous rise without a platform.

(G) Flow Measurement. Flow measurement facilities shall be provided at all plants. Indicating, totalizing and recording flow measurement devices shall be provided for all mechanical plants. Flow measurement facilities for lagoon systems shall not be less than pump calibration time clocks or calibrated flume and shall be provided on both the influent and effluent.

(9) Safety. Adequate provision shall be made to effectively protect the operator and visitors from hazards, the following shall be provided to fulfill the particular needs of each plant: enclosure of the plant site with a fence designed to discourage the entrance of unauthorized persons and animals; installation of hand rails and guards around tanks, trenches, pits, stairwells and other hazardous structures; provision of first-aid equipment; posting of "No Smoking" signs in hazardous areas; provision of protective clothing and equipment such as air pacs, goggles, gloves, hard hats, safety harnesses, etc.; provision of portable blower and sufficient hose; portable lighting equipment approved by the United States Bureau of Mines; and appropriately placed warning signs for slippery areas, non-potable water fixtures, low head clearance areas, open service manhole, hazardous chemical storage areas, flammable fuel storage areas, etc.

(A) Hazardous Chemical Handling.

1. Containment materials. The materials utilized for storage, piping, valves, pumping, metering, splash guards, etc., shall be specially selected considering the physical and chemical characteristics of each hazardous or corrosive chemical.

2. Secondary containment. Chemical storage areas shall be enclosed in dikes or curbs which will contain the stored volume until it can be safely transferred to alternate storage or released to the wastewater at controlled rates which will not damage the facilities, inhibit the treatment process or contribute to stream pollution. Liquid polymer should be similarly contained to reduce areas with slippery floors, especially to protect travelways. Nonslip floor surfaces are desirable in polymer-handling areas.

3. Eye wash fountains and safety showers. Eye wash fountains and safety showers utilizing potable water shall be provided in the laboratory and on each floor level or work location involving hazardous or corrosive chemical storage, mixing (or slaking), pumping, metering or transportation unloading. These facilities are to be as close as practicable to possible chemical exposure sites and are to be fully useful during all weather conditions. The eye wash fountains shall be supplied with water of moderate temperature—fifty degrees to ninety degrees Fahrenheit (50°–90°F) (ten degrees to thirty-two degrees Celsius (10°–32°C)), separate from the hot water supply, suitable to provide fifteen to thirty (15–30) minutes of continuous irrigation of the eyes. The emergency showers shall be capable of discharging thirty to fifty gallons per day (30–50 gpm) (1.9–3.2 l/s) of water at moderate temperature at pressures of twenty to fifty pounds per square inch (20–50 psi) (1.41–3.52 kgf/cm^2). The eye wash fountains and showers shall be no more than twenty-five feet (25') (7.6 m) from points of hazardous chemical exposure.

4. Splash guards. All pumps or feeders for hazardous or corrosive chemicals shall have guards which will effectively prevent spray of chemicals into space occupied by personnel. The splash guards are in addition to guards to prevent injury from moving or rotating machinery parts.

5. Piping, labeling, coupling guards, location. All piping containing or transporting corrosive or hazardous chemicals shall be identified with labels every ten feet (10') (3.0m) and with at least two (2) labels in each room, closet or pipe chase. Color coding may also be used but is not an adequate substitute for labeling. All connections (flanged or other type), except adjacent to storage or feeder areas, shall have guards which will direct any leakage away from space occupied by personnel. Pipes containing hazardous or corrosive chemicals should not be located above shoulder level except where continuous drip collection trays and coupling guards will eliminate spray or dripping onto personnel.

6. Protective clothing and equipment. The following items of protective clothing or equipment shall be available and utilized for all operations or procedures where their use will minimize injury hazard to personnel: respirators, air supply type recommended for protection against chlorine; chemical workers' goggles or other suitable goggles (safety glasses are insufficient); face masks or shields for use over goggles; rubber gloves, rubber aprons with leg straps; rubber boots (leather and wool clothing should be avoided near caustics); and safety harness and line.

7. Warning system and signs. Facilities shall be provided for automatic shutdown of pumps and sounding of alarms when failure occurs in a pressurized chemical discharge line. Warning signs requiring use of goggles shall be located near chemical unloading stations, pumps and other points of frequent hazard.

8. Dust collection. Dust collection equipment shall be provided to protect personnel from dusts injurious to the lungs or skin and to prevent polymer dust from settling on walkways. The latter is to minimize slick floors which result when a polymer-covered floor becomes wet.

9. Container identification. The identification and hazard warning data included on shipping containers, when received shall appear on all containers (regardless of size or type) used to store, carry or use a hazardous substance. Sewage and sludge sample containers should be adequately labeled. Following is a suitable label for a sewage sample:

<u>RAW SEWAGE</u>

Sample point No.

Contains Harmful Bacteria.

May contain hazardous
or toxic material.

Do not drink or swallow.

Avoid contact with openings
or breaks in the skin.

AUTHORITY: section 644.026, RSMo Supp. 1989. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.150 Screening, Grit Removal and Flow Equalization

PURPOSE: The following criteria have been prepared as a guide for the design of screening, grit removal and flow equalization facilities. This rule is to be used with rules 10 CSR

20-8.110–10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers ***Recommended Standards for Sewage Works*** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons per day ($85.4m^3$) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) Screening Devices.

(A) Bar Racks and Screens.

1. When required. Protection for pumps and other equipment shall be provided by either coarse bar racks or bar screens. Protection for comminutors should be provided by coarse bar racks.

2. Location.

A. Indoors. Screening devices, installed in a building where other equipment or offices are located, should be accessible only through a separate outside entrance.

B. Outdoors. Screening devices installed outside shall be protected from freezing.

C. Access. Screening areas shall be provided with stairway access, adequate lighting and ventilation and a convenient and adequate means for removing the screenings.

3. Design and installation.

A. Bar spacing. Clear opening between bars should be no less than one inch (1") (2.54 cm) for manually cleaned screens. Clear openings for mechanically cleaned screens may be as small as five-eighths of an inch (5/8") (1.50 cm). Maximum clear openings should be one and three-fourths inches (1 3/4") (4.45 cm).

B. Slope. Manually cleaned screens, except those for emergency use, should be placed on a slope of thirty to forty-five degrees (35°–45°) on the horizontal.

C. Velocities. At normal operating flow conditions, approach velocities should be no less than 1.25 feet per second (38.1 cm/sec), to prevent settling; and no greater than 3.0 fps (91.4 cm/sec) to prevent forcing material through the openings.

D. Channels. Dual channels shall be provided and equipped with the necessary gates to isolate flow from any screening unit. Provisions shall also be made to facilitate dewatering each unit. The channel preceding and following the screen shall be shaped to eliminate stranding and settling of solids.

E. Invert. The screen channel invert should be three to six inches (3–6") (7.6–15.2 cm) below the invert of the incoming sewer.

F. Flow distribution. Entrance channels should be designed to provide equal and uniform distribution of flow to the screens.

G. Flow measurement. Flow measurement devices should be selected for reliability and accuracy. The effect of changes in backwater elevations, due to intermittent cleaning of screens, should be considered in locations of flow measurement equipment.

4. Safety.

A. Railings and gratings. Manually cleaned screen channels shall be protected by guard railings and deck gratings with adequate provisions for removal or opening to facilitate raking. Mechanically cleaned screen channels shall be protected by guard railings and deck gratings. Consideration should also be given to temporary access arrangements to facilitate maintenance and repair.

B. Mechanical devices. Mechanical screening equipment shall have adequate removal enclosures to protect personnel against accidental contact with moving parts and to prevent dripping in multi-level installations. A positive means of locking out each mechanical device shall be provided.

5. Control systems.

A. Timing devices. All mechanical units which are operated by timing devices shall be provided with auxiliary controls which will set the cleaning mechanism in operation at a pre-set high water elevation.

B. Electrical fixtures and controls. Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location).

C. Manual override. Automatic controls shall be supplemented by a manual override.

6. Disposal of screenings. Facilities must be provided for removal, handling, storage and disposal of screenings in a sanitary manner. Separate grinding of screenings and return to the sewage flow is unacceptable. Manually cleaned screening facilities should include an accessible platform from which the operator may rake screenings easily and safely. Suitable drainage facilities shall be provided for both the platform and storage areas.

7. Auxiliary screens. Where a single mechanically cleaned screen is used, an auxiliary manually cleaned screen shall be provided. Where two (2) or more mechanically cleaned screens are used, the design shall provide for taking any unit out-of-service without sacrificing the capability to handle the peak design flow.

(B) Fine Screens.

1. General. Fine screens may be used in lieu of primary sedimentation providing that subsequent treatment units are designed on the basis of anticipated screen performance. Fine screens should not be considered equivalent to primary sedimentation. Where fine screens are used, additional provisions for the removal of floatable oils and greases shall be considered.

2. Design. Tests should be conducted to determine BOD_5 and suspended solids removal efficiencies at the design peak hydraulic and peak organic loadings. A minimum of two (2) fine screens shall be provided; each unit being capable of independent operation. Capacity shall be provided to treat peak design flows with one (1) unit out-of-service. Fine screens shall be preceded by a

mechanically cleaned bar screen or other protective device. Comminuting devices shall not be used ahead of fine screens.

3. Electrical fixtures and controls. Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location).

4. Servicing. Hosing equipment shall be provided to facilitate cleaning. Provisions shall be made for isolating or removing units from their location for servicing.

(4) Comminutors.

(A) General. Provisions for location shall be in accordance with screening devices, paragraph (3)(A)2. of this rule.

(B) When Required. Comminutors shall be used in plants that do not have primary sedimentation or fine screens and should be provided in cases where mechanically cleaned bar screens will not be used.

(C) Design Considerations.

1. Location. Comminutors should be located downstream of any grit removal equipment.

2. Size. Comminutor capacity shall be adequate to handle peak flows.

3. Installation. A screened bypass channel shall be provided. The use of the bypass channel should be automatic at depths of flow exceeding the design capacity for the comminutor. Each comminutor that is not preceded by grit removal equipment should be protected by a six inch (6.0") (15.2 cm) deep gravel trap. Gates shall be provided in accordance with subparagraph (3)(A)3.D. of this rule.

4. Servicing. Provisions shall be made to facilitate servicing units in place and removing units from their location for servicing.

5. Electrical controls and motors. Electrical equipment in comminutor chambers where hazardous gases may accumulate shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location). Motors in areas not governed by this requirement may need protection against accidental submergence.

(5) Grit Removal Facilities.

(A) When Required. Grit removal facilities should be provided for all sewage treatment plants; and are required for plants receiving sewage from combined sewers or from sewer systems receiving substantial amounts of grit. If a plant serving a separate sewer system is designed without grit facilities, the design shall include provisions for future installation. Consideration shall be given to possible damaging effects on pumps, comminutors and other preceding equipment and the need for additional storage capacity in treatment units where grit is likely to accumulate.

(B) Location.

1. General. Grit removal facilities should be located ahead of pumps and comminuting devices. Coarse bar racks should be placed ahead of grit removal facilities.

2. Housed facilities.

A. Ventilation. Uncontaminated air shall be introduced continuously at a rate of twelve (12) air changes per hour or intermittently at a rate of thirty (30) air changes per hour. Odor control facilities may also be warranted.

B. Access. Adequate stairway access to above or below grade facilities shall be provided.

C. Electrical. All electrical work in enclosed grit removal areas where hazardous gases may accumulate shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location).

3. Outside facilities. Grit removal facilities located outside shall be protected from freezing.

(C) Type and Number of Units. Plants treating wastes from combined sewers should have at least two (2) mechanically cleaned grit removal units with provisions for bypassing. A single manually cleaned or mechanically cleaned grit chamber with bypass is acceptable for small sewage treatment plants serving separate sanitary sewer systems. Minimum facilities for larger plants serving separate sanitary sewers should be at least one (1) mechanically cleaned unit with a bypass. Facilities other than channel-type are acceptable if provided with adequate and flexible controls for agitation and/or air supply devices and with grit collection and removal equipment.

(D) Design Factors.

1. General. The design effectiveness of a grit removal system shall be commensurate with the requirements of the subsequent process units.

2. Inlet. Inlet turbulence shall be minimized.

3. Velocity and detention. Channel-type chambers shall be designed to control velocities during normal variations in flow as close as possible to one foot (1') per second (30 cm/sec). The detention period shall be based on the size of particle to be removed. All grit removal facilities should be provided with adequate automatic control devices to regulate detention time, agitation or air supply.

4. Grit washing. The need for grit washing should be determined by the method of final grit disposal.

5. Drains. Provisions shall be made for isolating and de-watering each unit.

6. Water. An adequate supply of water under pressure shall be provided for cleanup.

7. Grit handling. Grit removal facilities located in deep pits should be provided with mechanical equipment for hoisting or transporting grit to ground level. Impervious nonslip working surfaces with adequate drainage shall be provided for grit handling areas. Grit transporting facilities shall be provided with protection against freezing and loss of material.

(6) Pre-aeration of sewage to reduce septicity may be required in special cases.

(7) Flow Equalization.

(A) General. Flow equalization can reduce the dry weather variations in organic and hydraulic loadings at any wastewater treatment plant. It should be provided where large diurnal variations are expected.

(B) Location. Equalization basins should be located downstream of pretreatment facilities such as bar screens, comminutors and grit chambers.

(C) Type. Flow equalization can be provided by using separate basins or on-line treatment units such as aeration tanks. Equalization basins may be designed as either in-line or side-line units. Unused treatment units, such as sedimentation or aeration tanks, may be utilized as equalization basins during the early period of design life.

(D) Size. Equalization basin capacity should be sufficient to effectively reduce expected flow and load variations to the extent deemed to be economically advantageous. With a diurnal flow pattern, the volume required to achieve the desired degree of equalization can be determined from a cumulative flow plot over the representative twenty-four (24)-hour period.

(E) Operation.

1. Mixing. Aeration or mechanical equipment shall be provided to maintain adequate mixing. Corner fillets and hopper bottoms with draw-offs should be provided to alleviate the accumulation of sludge and grit.

2. Aeration. Aeration equipment shall be sufficient to maintain a minimum of 1.0 mg/l of dissolved oxygen in the mixed basin contents at all times. Air supply rates should be a minimum of 1.25 cfm per one thousand gallons (1000 gal) (9 l/min/m^3) of storage capacity. The air supply should be isolated from other treatment plant aeration requirements to facilitate process aeration control.

Standard process aeration supply equipment may be utilized as a source of standby aeration.

3. Controls. Inlets and outlets for all basin compartments shall be suitably equipped with accessible external valves, stop plates, weirs or other devices to permit flow control and the removal of an individual unit from service. Facilities shall also be provided to measure and indicate liquid levels and flow rates.

(F) Electrical. All electrical work in housed equalization basins shall be suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location).

(G) Access. Suitable access shall be provided to facilitate the maintenance of equipment and cleaning.

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.160 Settling

PURPOSE: The following criteria have been prepared as a guide for the design of settling tanks. This rule is to be used with rules 10 CSR 20-8.110–10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers ***Recommended Standards for Sewage Works*** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

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(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, referred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred gallons per day (22,500 gpd) ($85.4m^3$) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) General Considerations.

(A) Number of Units. Multiple units capable of independent operation are desirable and shall be provided in all plants where design flows exceed one hundred thousand (100,000) gpd ($379m^3/d$). Plants not having multiple units shall include other provisions to assure continuity of treatment.

(B) Arrangement. Settling tanks shall be arranged in accordance with subsection 10 CSR 20-8.140(5)(E).

(C) Flow Distribution. Effective flow measurement devices and control appurtenances (that is, valves, gates, splitter boxes, etc.) shall be provided to permit proper proportion of flow to each unit.

(D) Tank Configuration. Consideration should be given to the probable flow pattern in the selection of tank size and shape, and inlet and outlet type and location.

(4) Design Considerations.

(A) Dimensions. The minimum length of flow from inlet to outlet should be ten feet (10') (3m) unless special provisions are made to prevent short-circuiting. The sidewater depth for primary clarifiers shall be as shallow as practicable, but not less than seven feet (7') (2.1m). Clarifiers following the activated sludge process shall have sidewater depths of at least twelve feet (12') (3.7m) to provide adequate separation zone between the sludge blanket and the overflow weirs. Clarifiers following fixed film reactors shall have sidewater depth of at least seven feet (7') (2.1m).

(B) Surface Settling Rates (Overflow Rates).

1. Primary settling tanks. Surface settling rates for primary tanks should not exceed one thousand (1000) gpd per square foot ($41m^3/m^2/day$) at design average flows or one thousand five hundred (1500) gpd per square foot ($61m^3m^2/day$) for peak hourly flows. Clarifier sizing shall be calculated for both flow conditions and the larger surface area determined shall be used. Primary settling of normal domestic sewage can be expected to remove thirty to fifty percent (30-50%) of the influent BOD. However, anticipated BOD removal for sewage containing appreciable quantities of industrial wastes (or chemical additions to be used) should be determined by laboratory tests and consideration of the quantity and character of the wastes.

2. Intermediate settling tanks. Surface settling rates for intermediate settling tanks following series units of fixed film reactor processes shall not exceed one thousand five hundred (1500) gpd per square foot ($61m^3/m^2/day$) based on peak hourly flow.

3. Final settling tanks. Settling tests should be conducted wherever pilot study of biological treatment is warranted by unusual waste characteristics or treatment requirements. Testing shall be done where proposed loadings go beyond the limits set forth in this section. Surface settling rates for settling tanks following trickling filters or rotating biological contractors shall not exceed one thousand two hundred (1200) gpd per square foot ($49m^3/m^2/day$) based on peak hourly flow. Final settling tanks following activated sludge processes must be designed to meet thickening as well as solids separation requirements. Since the rate of recirculation of return sludge from the final settling tanks to the aeration or re-aeration tanks is quite high in activated sludge processes, surface settling rate and weir overflow rate should be adjusted for the various processes to minimize the problems with sludge loadings, density currents, inlet hydraulic turbulence and occasional poor sludge settleability. The hydraulic design of intermediate and final settling tanks following activated sludge processes shall be based upon the anticipated peak hourly rate for the area downstream of the inlet baffle. The hydraulic loadings shall not exceed—one thousand two hundred (1200) gpd per square foot ($49m^3/m^2/day$) for conventional, step aeration, contact stabilization and the carbonaceous stage of separate-stage nitrification; one thousand (1000) gpd

per square foot ($41m^3/m^2$/day) for extended aeration; and eight hundred (800) gpd per square foot ($33m^3/m^2$/day) for the separate nitrification stage. The solids loading for all activated sludge processes shall not exceed fifty pounds (50 lbs.) solids per day per square foot (244 kg/m^2/day) at the peak rate. Consideration should be given to flow equalization.

(C) Inlet Structures. Inlets should be designed to dissipate the inlet velocity, to distribute the flow equally both horizontally and vertically and to prevent short-circuiting. Channels should be designed to maintain a velocity of at least one foot (1') per second (0.3m/s) at one-half (1/2) the design flow. Corner pockets and dead ends should be eliminated and corner fillets or channeling used where necessary. Provisions shall be made for elimination or removal of floating materials in inlet structures.

(D) Weirs.

1. General. Overflow weirs shall be adjustable for leveling.

2. Location. Overflow weirs shall be located to optimize actual hydraulic detention time, and minimize short-circuiting.

3. Design rates. Weir loadings should not exceed ten thousand (10,000) gpd per lineal foot ($124m^3$/m/day) for plants designed for average flows of 1.0 mgd ($3,785m^3$/day) or less. Higher weir loadings may be used for plants designed for larger average flows but should not exceed fifteen thousand (15,000) gpd per lineal foot ($186m^3$/m/day). If pumping is required, weir loadings should be related to pump delivery rates to avoid short-circuiting.

4. Weir troughs. Weir troughs shall be designed to prevent submergence at maximum design flow and to maintain a velocity of at least one foot (1') per second (0.3m/s) at one-half (1/2) the design flow.

(E) Submerged Surfaces. The tops of troughs, beams and similar submerged construction elements shall have a minimum slope of 1.4:1; the underside of the elements should have a slope of one to one (1:1) to prevent the accumulation of scum and solids.

(F) Unit De-watering. Unit de-watering features shall conform to the provisions outlined in 10 CSR 20-8.140(6). The unit isolation design should also provide for redistribution of the plant flow to the remaining units.

(G) Freeboard. Walls of settling tanks shall extend at least six inches (6") (15 cm) above the surrounding ground surface and shall provide not less than twelve inches (12") (30 cm) freeboard. Additional freeboard or the use of wind screens is recommended where larger settling tanks are subject to high velocity wind currents that would cause tank surface waves and inhibit effective scum removal.

(5) Sludge and Scum Removal.

(A) Scum Removal. Effective scum collection and removal facilities, including baffling, shall be provided for all settling tanks. The unusual characteristics of scum which may adversely affect pumping, piping, sludge handling and disposal should be recognized in design. Provisions may be made for the discharge of scum with the sludge; however, other special provisions for disposal may be necessary.

(B) Sludge Removal. Sludge collection and withdrawal facilities shall be so designed as to assure rapid removal of the sludge. Suction withdrawal should be provided for activated sludge plants designed for reduction of the nitrogenous oxygen demand and is encouraged for those plants designed for carbonaceous oxygen demand reduction.

1. Sludge hopper. The minimum slope of the side walls shall be 1.7:1. Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal. Hopper bottoms shall have a maximum dimension of two feet (2') (.6m). Extra depth sludge hoppers for sludge thickening are not acceptable.

2. Cross-collectors. Cross-collectors serving one (1) or more settling tanks may be useful in place of multiple sludge hoppers.

3. Sludge removal piping. Each hopper shall have an individually-valved sludge withdrawal line at least six inches (6") (15 cm) in diameter. The static head available for withdrawal of sludge shall be thirty inches (30") (76 cm) or greater as necessary to maintain a three-foot (3') per second (0.9m/s) velocity in the withdrawal pipe. Clearance between the end of the withdrawal line and the hopper walls shall be sufficient to prevent bridging of the sludge. Adequate provisions shall be made for rodding or back-flushing individual pipe runs. Piping shall also be provided to return waste sludge to primary clarifiers.

4. Sludge removal control. Sludge wells equipped with telescoping valves or other appropriate equipment shall be provided for viewing, sampling and controlling the rate of sludge withdrawal. The use of easily maintained sight glass and sampling valves may be appropriate. A means of measuring the sludge removal rate shall be provided. Air lift type of sludge removal will not be approved for removal of primary sludges. Sludge pump motor control system shall include time clocks and valve activators for regulating the duration and sequencing of sludge removal.

(6) Protective and Service Facilities.

(A) Operator Protection. All settling tanks shall be equipped to enhance safety for operators. These features shall appropriately include machinery covers, life lines, stairways, walkways, hand rails and slip-resistant surfaces.

(B) Mechanical Maintenance Access. The design shall provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal, mechanism and baffles, weirs, inlet stilling baffle area and effluent channels.

(C) Electrical Fixtures and Controls. Electrical fixtures and controls in enclosed settling basins shall be suitable for hazardous locations (National Electrical Code for Class I, Group D, Division 1 location). The fixtures and controls shall be located so as to provide convenient and safe access for operation and maintenance. Adequate area lighting shall be provided.

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.170 Sludge Handling and Disposal

PURPOSE: The following criteria have been prepared as a guide for the design of sludge handling and disposal facilities. This rule is to be used with rules 10 CSR 20-8.110—10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, ***Recommended Standards for Sewage Works*** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

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(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred gallons per day (22,500 gpd) (85.4m^3) or less (see 10 CSR 20-8.020) for the requirements for those facilities.

(3) Design Considerations. The selection of sludge handling and disposal methods should include the following considerations: energy requirements; efficacy of sludge thickening; complexity of equipment; staffing requirements; toxic effects of heavy metals and other substances on sludge stabilization and disposal; treatment of side-stream flow such as digester and thickener supernatant; a back-up method of sludge handling and disposal; and methods of ultimate sludge disposal.

(4) Sludge Thickeners. As the first step of sludge handling, the need for sludge thickeners to reduce the volume of sludge should be considered. The design of thickeners (gravity, dissolved air flotation, centrifuge and others) should consider the type and concentration of sludge, the sludge stabilization processes, the method of ultimate sludge disposal, chemical needs and the cost of operation. Particular attention should be given to the pumping and piping of the concentrated sludge and possible onset of anaerobic conditions. Sludge should be thickened to at least five percent (5%) solids prior to transmission to digesters.

(5) Anaerobic Sludge Digestion.

(A) General.

1. Multiple units. Multiple tanks are recommended. Where a single digestion tank is used, an alternate method of sludge processing or emergency storage to maintain continuity of service shall be provided.

2. Depth. For those units proposed to serve as supernatant separation tanks, the depth should be sufficient to allow for the formation of a reasonable depth of supernatant liquor. A minimum sidewater depth of twenty feet (20') (6.10m) is recommended.

3. Maintenance provisions. To facilitate draining, cleaning and maintenance, the following features are desirable:

A. Slope. The tank bottom should slope to drain toward the withdrawal pipe. For tanks equipped with a suction mechanism for withdrawal of sludge, a bottom slope of one to twelve (1:12) or greater is recommended. Where the sludge is to be removed by gravity alone, one to four (1:4) slope is recommended.

B. Access manholes. At least two (2) thirty-six inch (36") (91 cm) diameter access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate sidewall manhole shall be provided. The opening should be large enough to permit the use of mechanical equipment to remove grit and sand.

C. Safety. Nonsparking tools, safety lights, rubber-soled shoes, safety harness, gas detectors for inflammable and toxic gases, and at least two (2) self-contained breathing units shall be provided for emergency use.

(B) Sludge Inlets and Outlets. Multiple recirculation withdrawal and return points should be provided to enhance flexible operation and effective mixing, unless mixing facilities are incorporated within the digester. The returns, in order to assist in scum breakup, should discharge above the liquid level and be located near the center of the tank. Raw sludge discharge to the digester should be through the sludge heater and recirculation return piping or directly to the tank if internal mixing facilities are provided. Sludge withdrawal to disposal should be from the bottom of the tank. This pipe should be interconnected with the recirculation piping to increase versatility in mixing the tank contents, if the piping is provided. Sludge withdrawal should be at the bottom of the tank.

(C) Tank Capacity. The total digestion tank capacity should be determined by rational calculations based upon such factors as volume of sludge added, its percent solids and character, the temperature to be maintained in the digesters, the degree or extent of mixing to be obtained and the degree of volatile solids reduction required. Calculations should be submitted to justify the basis of design. When the calculations are not based on these factors, the minimum combined digestion tank capacity outlined in paragraphs (5)(C)1. and 2. will be required. The requirements assume that a raw sludge is derived from ordinary domestic wastewater, that a digestion temperature is to be maintained in the range of ninety degrees to one hundred degrees Fahrenheit (90°–100°F) (32.2°C–37.8°C), that forty to fifty percent (40–50%) volatile matter will be maintained in the digested sludge, and that the digested sludge will be removed frequently from the system (see also paragraph (5)(A)1. of this rule).

1. Completely-mixed systems. Completely-mixed systems shall provide for intimate and effective mixing to prevent stratification and to assure homogeneity of digester content. The system may be loaded at a rate up to eighty pounds (80 lbs.) of volatile solids per one thousand (1000) cubic feet of volume per day (1.28 kg/m^3/day) in the active digestion units. When grit removal facilities are not provided, the reduction of digester volume due to grit accumulation should be considered. Complete mixing can be accomplished only with substantial energy input.

2. Moderately-mixed systems. For digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded at a rate up to forty pounds (40 lbs.) of volatile solids per one thousand (1000) cubic feet of volume per day (0.64 kg/m^3/day) in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided. Provisions for mixing scum shall be included.

(D) Gas Collection, Piping and Appurtenances.

1. General. All portions of the gas system, including the space above the tank liquor, storage facilities and piping, shall be so designed that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

2. Safety equipment. All necessary safety facilities shall be included where gas is produced. Pressure and vacuum relief valves and flame traps, together with automatic safety shutoff valves, shall be provided. Water seal equipment shall not be installed. Gas safety equipment and gas compressors should be housed in a separate room with an exterior entrance.

3. Gas piping and condensate. Gas piping shall be of adequate diameter and shall slope to condensate traps at low points. The use of float-controlled condensate traps is not permitted.

4. Gas utilization equipment. Gas-fired boilers for heating digesters shall be located in a separate room not connected to the digester gallery. The separated room would not ordinarily be classified as hazardous location. Gas lines to these units shall be provided with suitable flame traps.

5. Electrical fixtures. Electrical fixtures and controls in places enclosing anaerobic digestive appurtenances where hazardous gases are normally contained in the tanks and/or piping shall comply with the National Electrical Code, Class I, Group D, Division 2 locations. Digester galleries should be isolated from normal operating areas to avoid an extension of the hazardous location in accordance with paragraph (5)(D)7. of this rule.

6. Waste gas. Waste gas burners shall be readily accessible and should be located at least twenty-five feet (25') (7.6m) away from any plant structure if placed at ground level or may be located on the roof of the control building if sufficiently removed from the tank. All waste gas burners shall be equipped with automatic ignition, such as pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to insure reliability of the pilot light. In remote locations it may be permissible to discharge the gas to the atmosphere through a return-bend screened vent terminating at least ten feet (10') (3m) above the ground surface, provided that the assembly incorporates a flame trap.

7. Ventilation. Any underground enclosures connecting with digestion tanks or containing sludge or gas piping or equipment shall be provided with forced ventilation in accordance with 10 CSR 20-8.130(4)(G) and 10 CSR 20-8.130(4)(G)2. The piping gallery for digesters should not be connected to other passages. Where used, tightly fitting, self-closing doors should be provided at connecting passageways and tunnels to minimize the spread of gas.

8. Meter. A gas meter with bypass shall be provided to meter total gas production.

(E) Digester Heating.

1. Insulation. Wherever possible digestion tanks should be constructed above groundwater level and should be suitably insulated to minimize heat loss.

2. Heating facilities. Sludge may be heated by circulating the sludge through external heaters or by heating units located inside the digestion tank.

A. External heating. Piping shall be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions shall be made in the layout of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping should be sized for heat transfer requirements.

B. Other heating methods. Other types of heating facilities will also be considered on their own merits.

3. Heating capacity. Heating capacity sufficient to consistently maintain the design sludge temperature shall be provided. Where digester tank gas is used for sludge heating, an auxiliary fuel supply is required.

4. Hot water internal heating controls.

A. Mixing valves. A suitable automatic mixing valve shall be provided to temper the boiler water with return water so that the inlet water to the heat jacket can be held below a temperature at which caking will be accentuated. Manual control should also be provided by suitable bypass valves.

B. Boiler controls. The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately one hundred eighty degrees Fahrenheit (180°F) (82°C) to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level or excessive temperature.

C. Thermometers shall be provided to show temperatures of the sludge, hot water feed, hot water return and boiler water.

(F) Supernatant Withdrawal.

1. Piping size. Supernatant piping should not be less than six inches (6") (15 cm) in diameter.

2. Withdrawal arrangements.

A. Withdrawal levels. Piping should be arranged so that withdrawal can be made from three (3) or more levels in the digester. A positive unvalved vented overflow shall be provided.

B. Supernatant selector. If a supernatant selector is provided, provisions shall be made for at least one (1) other draw-off level located in the supernatant zone of the tank in addition to the unvalved emergency supernatant draw-off pipe. High pressure backwash facilities shall be provided.

3. Sampling. Provisions should be made for sampling at each supernatant draw-off level. Sampling pipes should be at least one and one-half inches (1 1/2") (3.8 cm) in diameter and should terminate at a suitably-sized sampling sink or basin.

4. Alternate supernatant disposal. Consideration should be given to supernatant conditioning where appropriate in relation to its effect on plant performance and effluent quality.

(6) Aerobic Sludge Digestion.

(A) General. Aerobic digestion can be used to stabilize primary sludge, secondary sludge or a combination of the two. Digestion is accomplished in single or multiple tanks designed to provide effective air mixing, reduction of the organic matter, supernatant separation and sludge concentration under controlled conditions.

1. Digestion tanks. Multiple tanks are recommended. A single sludge digestion tank may be used in the case of small treatment plants or where adequate provision is made for sludge handling where a single unit will not adversely affect normal plant operations.

(B) Mixing and Air Requirements. Aerobic sludge digestion tanks shall be designed for effective mixing by satisfactory aeration equipment. Sufficient air shall be provided to keep the solids in suspension and maintain dissolved oxygen between one and two (1-2) mg/l. A minimum mixing and oxygen requirement of thirty (30) cfm per one thousand (1000) cubic feet of tank volume (30 $l/min/m^3$) shall be provided with the largest blower out-of-service. If diffusers are used, the nonclog type is recommended, and they should be designed to permit continuity of service. If mechanical aerators are utilized, a minimum of 1.0 horsepower per one thousand (1000) cubic feet ($28.3m^3$) should be provided. Use of mechanical equipment is discouraged where freezing temperatures are normally expected.

(C) Tank Capacity. The determination of tank capacities shall be based on rational calculations, including such factors as quantity of sludge produced, sludge characteristics, time of aeration and sludge temperature.

1. Volatile solids loading. It is recommended that the volatile suspended solids loading not exceed one hundred pounds per one thousand cubic feet (100 $lb/1000\ ft^3$) of volume per day (1.60 $kg/m^3/day$) in the digestion units. Lower loading rates may be necessary depending on temperature, type of sludge and other factors.

2. Solids retention time. Required minimum solids retention time for stabilization of biological sludges vary depending on type of sludge. Normally, a minimum of fifteen (15) days' retention should be provided for waste activated sludge and twenty (20) days for combination of primary and waste activated sludge, or primary sludge alone. Where sludge temperature is lower than fifty degrees Fahrenheit (50°F) (10°C), additional detention time should be considered.

(D) Supernatant Separation. Facilities shall be provided for effective separation and withdrawal of supernatant and for effective collection and removal of scum and grease.

(7) Sludge Pumps and Piping.

(A) Sludge Pumps.

1. Capacity. Pump capacities should be adequate but not excessive. Provision for varying pump capacity is desirable.

2. Duplicate units. Duplicate units shall be provided where failure of one (1) unit would seriously hamper plant operation.

3. Type. Plunger pumps, screw feed pumps, recessed impeller type centrifugal pumps, progressive cavity pumps or other types of pumps with demonstrated solids handling capability shall be provided for handling raw sludge. Where centrifugal pumps are used, a parallel plunger type pump should be provided as an alternate to increase reliability of the centrifugal pump.

4. Minimum head. A minimum positive head of twenty-four inches (24") (61 cm) shall be provided at the suction side of centrifugal type pumps and is desirable for all types of sludge pumps. Maximum suction lifts should not exceed ten feet (10') (3m) for plunger pumps.

5. Sampling facilities. Unless sludge sampling facilities are otherwise provided, quick closing sampling valves shall be installed at the sludge pumps. The size of valve and piping should be at least one and one-half inches (1 1/2") (3.8 cm).

(B) Sludge Piping.

1. Size and head. Sludge withdrawal piping should have a minimum diameter of eight inches (8") (20.3 cm) for gravity withdrawal and six inches (6") (15.2 cm) for pump suction and discharge lines. Where withdrawal is by gravity the available head on the discharge pipe should be adequate to provide at least three feet (3') per second (0.9m/sec) velocity.

2. Slope. Gravity piping should be laid on uniform grade and alignment. The slope of gravity discharge piping should not be less than three percent (3%). Provisions should be made for cleaning, draining and flushing discharge lines.

3. Supports. Special consideration should be given to the corrosion resistance and continuing stability of supporting systems located inside the digestion tank.

(8) Sludge De-watering.

(A) Sludge Drying Beds.

1. Area. In determining the area of sludge drying beds, consideration shall be given to climatic conditions, the character and volume of the sludge to be de-watered, the method and schedule of sludge removal and other methods of sludge disposal. (It should be recognized that, in northern areas of the country, the drying season is only six (6) months a year.) In general, the sizing of the drying bed may be estimated on the basis of 2.0 ft^2/capita ($0.2m^2$/capita) when the drying bed is the primary method of de-watering, and 1.0 ft^2/capita ($0.1m^2$/capita) if it is to be used as a back-up de-watering unit. An increase of bed area by twenty-five percent (25%) is recommended for paved-type bed.

2. Percolation type. The lower course of gravel around the underdrains should be properly graded and should be twelve inches (12") (30 cm) in depth, extending at least six inches (6") (15.2 cm) above the top of the under drains. It is desirable to place this in two (2) or more layers. The top layer of at least three inches (3") (7.6 cm) should consist of gravel one-eighth inch (1/8") to one-fourth inch (1/4") (3.2–6.4 mm) in size.

A. Sand. The top course should consist of at least six to nine inches (6"–9") (15–23 cm) of clean coarse sand. The finished sand surface should be level.

B. Underdrains. Underdrains should be clay pipe or concrete drain tile at least four inches (4") (10 cm) in diameter laid with open joints. Underdrains should be spaced not more than twenty feet (20') (6m) apart. As to the discharge of the underdrain filtrate, refer to subsection (8)(C) of this rule.

3. Partially paved type. The partially paved type drying bed should be designed with consideration for space requirement to operate mechanical equipment for removing the dried sludge.

4. Walls. Walls should be watertight and extend fifteen to eighteen inches (15"–18") (38 cm–46 cm) above and at least six inches (6") (15 cm) below the surface. Outer walls should be curbed to prevent soil from washing onto the beds.

5. Sludge removal. Not less than two (2) beds should be provided and they should be arranged to facilitate sludge removal. Concrete truck tracks should be provided for all percolation type sludge beds. Pairs of tracks for percolation type should be on twenty-foot (20') (6m) centers.

6. Sludge influent. The sludge pipe to the drying beds should terminate at least twelve inches (12") (30 cm) above the surface and be so arranged that it will drain. Concrete splash plates for percolation type should be provided at sludge discharge points.

7. Protective enclosure. A protective enclosure shall be provided if winter operation is required.

(B) Mechanical De-watering Facilities. Provision shall be made to maintain sufficient continuity of service so that sludge may be de-watered without accumulation beyond storage capacity. The number of vacuum filters, centrifuges, filter presses, belt filters or other mechanical de-watering facilities should be sufficient to de-water the sludge produced with one (1) largest unit out-of-service. Unless other standby facilities are available, adequate storage facilities shall be provided. The storage capacity should be sufficient to handle at least a three (3)-month sludge production.

1. Auxiliary facilities per vacuum filters. There shall be a back-up vacuum pump and filtrate pump installed for each vacuum filter. It is permissible to have an uninstalled back-up vacuum pump or filtrate pump for every three (3) or less vacuum filters, provided that the installed unit can easily be removed and replaced.

2. Ventilation. Adequate facilities shall be provided for ventilation of de-watering area. The exhaust air should be properly conditioned to avoid odor nuisance.

3. Chemical handling enclosures. Lime-mixing facilities should be completely enclosed to prevent the escape of lime dust. Chemical handling equipment should be automated to eliminate the manual lifting requirement.

(C) Drainage and Filtrate Disposal. Drainage from beds or filtrate from de-watering units shall be returned to the sewage treatment process at appropriate points.

(D) Other De-watering Facilities. If it is proposed to de-water or dispose of sludge by other methods, a detailed description of the process and design data shall accompany the plans.

(9) Municipal Sludge Disposal on Land. The program of land spreading of sludge must be evaluated as an integral system which include stabilization, storage, transportation, application, soil, crop and groundwater. The following guidelines were formulated to provide the criteria of municipal sludge disposal on land. Sewage sludge is useful to crop and soil by providing nutrients and organic matter. Sewage sludge contains heavy metals and other substances which could affect soil productivity and the quality of food. Sufficient information is not available to completely evaluate the deleterious effects. The purpose of the guidelines is to indicate the acceptable method of sludge disposal on land surface based on current knowledge. It is recognized that these guidelines should be revised as more information becomes available.

(A) General Limitations to be Observed.

1. Stabilized sludge. Only stabilized sludge shall be surface applied to farmland or pasture. Stabilized sludge is defined as processed sludge in which the organic and bacterial contents of raw sludge are reduced to levels deemed necessary by the agency to prevent nuisance odors and public health hazards. Any process which produces sludge equivalent in quality to the above in terms of

public health factors and odor potential may be accepted. Additional treatment would be required to further reduce pathogens when the sludge is to be spread on dairy pastures and other crops which are in the human food chain.

2. Raw vegetables. Sludge should not be applied to land which is used for growing food crops to be eaten raw, such as leafed vegetables and root crops.

3. Minimum pH. No sludge shall be applied on land if the soil pH is less than 6.5 when sludge is applied and pH shall be maintained above 6.5 for at least two (2) years following end of sludge application.

4. Persistent organic chemicals. At present time, sufficient information is not available to establish criteria of sludge spreading in regard to persistent organic chemicals, such as pesticides and polychlorinated biphenyls (PCB). However, if there is a known source in the sewer service area which discharges or discharged in the past such chemicals, the sludge should be analyzed for chemicals and the agency shall be consulted for recommendations concerning sludge spreading.

(B) Site Selection. By proper selection of the sludge application site, the nuisance potential and public health hazard should be minimized. The following items should be considered and the agency should be consulted for specific limits: land ownership information; groundwater table and bedrock location; location of dwellings, road and public access; location of wells, springs, creeks, streams and flood plains; slope of land surface; soil characteristics; climatological information and periods of ground freezing; land use plan; and road weight restrictions.

(C) Sludge Application on Farmland. Heavy metal loading to land should be limited in order to avoid reduction of soil productivity. A detailed chemical analysis of the sludge shall be made and the application rate shall be based on characteristics of the application site and crop uptake. The agency shall be contacted for specific limits.

(D) Sludge Application on Forested Land. Disposal of sludge on forested land is considerably less hazardous than on cropland in terms of heavy metal toxicity unless the land is to be converted to cropland. For the allowable sludge loading the agency should be consulted.

(E) Management of Spreading Operation.

1. Hauling equipment. The sludge hauling equipment should be designed to prevent spillage, odor and other public nuisance.

2. Valve control. The spreading tank truck should be provided with a control so that the discharge valve can be opened and closed by the driver while the vehicle is in motion. The spreading valve should be of the fail-safe type (that is, self-closing) or an additional manual standby valve should be employed to prevent uncontrolled spreading or spillage.

3. Sludge storage. Sufficient sludge storage capacity shall be provided for periods of inclement weather and equipment failure. The storage facilities shall be designed, located and operated so as to avoid nuisance conditions.

4. Spreading methods. The selection of spreading methods depends on the sludge characteristics, environmental factor and others. When control of odor nuisance and runoff is required, immediate incorporation of sludge after spreading or subsurface injection should be considered. When the a method is utilized, an adjustment in the reduced rate of ammonia loss into the atmosphere should be considered in the computation for nitrogen balance. The sewage sludge should be spread uniformly over the surface when tank truck spreading, ridge and furrow irrigation or other methods are used. Proposals for subsurface application of sludge shall include for review a description of the equipment and program for application. Spray systems except for downward directed types will not ordinarily be approved.

5. Boundary demarcation. The boundaries of the site shall be marked (for example, with stakes at corners) so as to avoid confusion regarding the location of the site during the sludge application. The markers should be maintained until the end of the current growing season.

6. Public access. Public access of the disposal site must be controlled by either positive barriers or remoteness of the site.

(F) Monitoring and Reporting. The requirement of the agency on the monitoring and reporting of sludge spreading operation should be followed. As a minimum, the producer of sludge should regularly collect and record information on the sludge and soil characteristics and volume of sludge spread to a particular site.

(10) Other Sludge Disposal Methods. When other sludge disposal methods, such as incineration and landfill, are considered, pertinent requirements from the agency shall be followed.

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.180 Biological Treatment

PURPOSE: The following criteria have been prepared as a guide for the design of biological treatment facilities. This rule is to be used with rules 10 CSR 20-8.110—10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers ***Recommended Standards for Sewage Works*** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that the name can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred gallons per day (22,500 gpd) ($85.4m^3$) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) Trickling Filters.

(A) General. Trickling filters may be used for treatment of sewage amenable to treatment by aerobic biologic processes. Trickling filters shall be preceded by effective settling tanks equipped with scum and grease collecting devices or other suitable pretreatment facilities. Filters shall be designed so as to provide the reduction in carbonaceous and/or nitrogenous oxygen demand in accordance with 10 CSR 20-7.015, Effluent Regulations and 10 CSR 20-7.031, Water Quality Standards, or to properly condition the sewage for subsequent treatment processes.

(B) Hydraulics.

1. Distribution.

A. Uniformity. The sewage may be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform distribution to the surface area. At design average flow, the deviation from a calculated uniformly distributed volume per square foot (m^2) of the filter surface shall not exceed plus or minus ten percent (±10%) at any point. All hydraulic factors involving proper distribution of sewage on the filters shall be submitted to the agency.

B. Head requirements. For reaction type distributions, a minimum head of twenty-four inches (24") (61 cm) between low water level in siphon chamber and center of arms is required. Similar allowance in design shall be provided for added pumping head requirements where pumping to the reaction type distributor is used.

C. Clearance. A minimum clearance of six inches (6") (15 cm) between media and distributor arms shall be provided. Greater clearance is essential where icing may occur.

2. Dosing. Sewage may be applied to the filters by siphons, pumps or by gravity discharge from preceding treatment units when suitable flow characteristics have been developed. Application of the sewage shall be practically continuous. The piping system shall be designed for recirculation.

3. Piping system. The piping system including dosing equipment and distributor shall be designed to provide capacity for the peak hourly flow rate including recirculation required under paragraph (3)(E)5. of this rule.

(C) Media.

1. Quality. The media may be crushed rock, slag or specially manufactured material. The media shall be durable, resistant to spalling or flaking and be relatively insoluble in sewage. The top eighteen inches (18") (46 cm) shall have a loss by the twenty (20)-cycle, sodium sulfate soundness test of not more than ten percent (10%), as prescribed by the *ASCE Manual of Engineering Practice*, Number 13; the balance is to pass a ten (10)-cycle test using the same criteria. Slag media shall be free from iron. Manufactured media shall be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalies, organic compounds and fungus and biological attack. Media shall be either structurally capable of supporting a man's weight or a suitable access walkway provided to allow for distributor maintenance.

2. Depth. Rock and/or slag filter media shall have a minimum depth of five feet (5') (1.5m) above the underdrains. Manufactured filter media should have a minimum depth of ten feet (10') (3m) to provide adequate contact time with the wastewater. Rock and/or slag filter media depths shall not exceed ten feet (10') (3m) and manufactured filter media depths shall not exceed thirty feet (30') (9.1m) except where special construction is justified through extensive pilot studies.

3. Size and grading of media.

A. Rock, slag and similar media. Rock, slag and similar media shall not contain more than five percent (5%) by weight of pieces whose longest dimension is three (3) times the least dimension. They shall be free from thin elongated and flat pieces, dust, clay, sand or fine material and shall conform to the following size and grading when mechanically graded over vibrating screen with square openings.

Passing 4 1/2-inch (4 1/2") screen (11.4 cm)—one hundred percent (100%) by weight.

Retained on 3-inch (3") screen (7.6 cm)—ninety-five to one hundred percent (95–100%) by weight.

Passing 2-inch (2") screen (5.1 cm)—0.2% by weight.

Passing 1-inch (1") screen (2.5 cm)—0.1% by weight.

B. Manufactured Media. Suitability will be evaluated on the basis of experience with installations handling similar wastes and loadings.

C. Handling and placing of media. Material delivered to the filter site shall be stored on wood planks or other approved clean hard surfaced areas. All material shall be rehandled at the filter site and no material shall be dumped directly into the filter. Crushed rock, slag and similar media shall be washed and rescreened or forked at the filter site to remove all fines. The material shall be placed by hand to a depth of twelve inches (12") (30 cm) above the tile underdrains and the remainder of material may be placed by means of belt conveyors or equally effective methods approved by the engineer. All material shall be carefully placed so as not to damage the underdrains. Manufactured media shall be handled and placed as approved by the engineer. Trucks, tractors or other heavy equipment shall not be driven over the filter during or after construction.

(D) Underdrainage System.

1. Arrangement. Underdrains with semicircular inverts or equivalent should be provided and the underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have an unsubmerged gross combined area equal to at least fifteen percent (15%) of the surface area of the filter.

2. Hydraulic capacity and ventilation. The underdrains shall have a minimum slope of one percent (1%). Effluent channels shall be designed to produce a minimum velocity of two feet (2') per second (0.61m/s) at average daily rate of application to the filter. The underdrainage system, effluent channels and effluent pipe shall be designed to permit free passage of air. The size of drains, channels and pipe should be so that not more than fifty percent (50%) of their cross section area will be submerged under the design peak hydraulic loading, including proposed or possible future or recirculated flows. Consideration shall be given to the use of forced ventilation, particularly for covered filters and deep manufactured media filters.

3. Flushing. Provision should be made for flushing the underdrains. In small filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities should be provided.

(E) Special Features.

1. Flooding. Appropriate valves, sluice gates or other structures shall be provided so as to enable flooding of filters comprised of rock or slag media for filter fly control.

2. Freeboard. A freeboard of four feet (4') (1.2 m) or more should be provided for tall, manufactured media filters to maximize the containment of windblown spray.

3. Maintenance. All distribution devices, underdrains, channels and pipes shall be installed so that they may be properly maintained, flushed or drained.

4. Winter protection. Adequate protection such as covers in severe climate or wind breaks in moderate climates shall be provided to maintain operation and treatment efficiencies when climatic conditions are expected to result in problems due to cold temperatures.

5. Recirculation. The piping system shall be designed for recirculation as required

to achieve the design efficiency. The recirculation rate shall be variable and subject to plant operator control.

6. Recirculation measurement. Devices shall be provided to permit measurement of the recirculation rate. Time lapse meters and pump head recording devices are acceptable for facilities treating less than one million gallons per day (1 mgd) ($3785m^3/d$).

(F) Rotary Distributor Seals. Mercury seals shall not be permitted. Ease of seal replacement shall be considered in the design to ensure continuity of operation.

(G) Multi-Stage Filters. The foregoing standards also apply to all multi-stage filters.

(H) Unit Sizing. Required volumes of rock or slag media filters shall be based upon pilot testing with the particular wastewater or any of the various empirical design equations that have been verified through actual full scale experience. Calculations must be submitted if pilot testing is not utilized. Pilot testing is recommended to verify performance predictions based upon the various design equations, particularly when significant amounts of industrial wastes are present. Expected performance of filters packed with manufactured media shall be determined from documented full scale experience at similar installation or through actual use of a pilot plant on-site.

(I) Design Safety Factors. Trickling filters are affected by diurnal load conditions. The volume of media determined from either pilot plant studies or use of acceptable design equations shall be based upon the design peak hourly organic loading rate rather than the average rate. An alternative would be to provide flow equalization.

(4) Activated Sludge.

(A) General.

1. Applicability.

A. Biodegradable wastes. The activated sludge process and its various modifications may be used where sewage is amenable to biological treatment.

B. Operational requirement. This process requires close attention and competent operating supervision, including routine laboratory control. These requirements shall be considered when proposing this type of treatment.

C. Energy requirement. This process requires major energy usage to meet aeration demands. Energy costs and potential mandatory emergency public power reduction events in relation to critical water quality conditions must be carefully evaluated. Capability of energy usage phase down while still maintaining process viability, both under normal and emergency availability conditions, must be included in the activated sludge design.

2. Specific process selection. The activated sludge process and its several modifications may be employed to accomplish varied degrees of removal of suspended solids and reduction of carbonaceous and/or nitrogenous oxygen demand. Choice of the process most applicable will be influenced by the degree and consistency of treatment required, type of waste to be treated, proposed plant size, anticipated degree of operation and maintenance, and operating and capital costs. All designs shall provide for flexibility in operation. Plants over one (1) mgd ($3785m^3/d$) shall be designed to facilitate easy conversion to various operation modes.

3. Winter protection. In severe climates, protection against freezing shall be provided to insure continuity of operation and performance.

(B) Pretreatment. Where primary settling tanks are not used, effective removal or exclusion of grit, debris, excessive oil or grease and comminution or screening of solids shall be accomplished prior to the activated sludge process. Where primary settling is used, provision shall be made for discharging raw sewage directly to the aeration tanks to facilitate plant start-up and operation during the initial stages of the plant's design life.

(C) Aeration.

1. Capacities and permissible loadings. The size of the aeration tank for any particular adaptation of the process shall be determined by full scale experience, plant pilot studies or rational calculations based mainly on food to microorganism ratio and mixed liquor suspended solids levels. Other factors such as size of treatment plant, diurnal load variations and degree of treatment required shall also be considered. In addition, temperature, pH and reactor dissolved oxygen shall be considered when designing for nitrification. Calculations should be submitted to justify the basis for design of aeration tank capacity. Calculations using values differing substantially from those in the accompanying table should reference actual operational plants. Mixed liquor suspended solids levels greater than five thousand (5000) mg/l may be allowed provided that adequate data is submitted that shows the aeration and clarification system is capable of supporting the levels. When process design calculations are not submitted, the aeration tank capacities and permissible loadings for the several adaptations of the processes shown in the following table shall be used. These values apply to plants receiving peak to average diurnal load ratios ranging from about two to one (2:1) to four to one (4:1). The utilization of flow equalization facilities to reduce the diurnal peak organic load may be considered by the agency as justification to approve organic loading rates that exceed those specified in the table.

Permissible Aeration Tank Capacities and Loadings

(NOTE: For proper use of this table, see paragraph (4)(C)1. of this rule.)

Process	Aeration Tank Organic Loading-lb. BOD_5/1,000 cu. ft./day	F/M Ratio-lb. BOD_5/lb. MLVSS/ day	MLSS* mg/liter
Step Aeration, Complete Mix, and Conventional	40	0.2–0.5	1000–3000
Contact Stabilization	50**	0.2–0.6	1000–3000
Extended Aeration and Oxidation-Ditches	15	0.05–0.1	3000–5000

*MLSS values are dependent upon the surface area provided for sedimentation and the rate of sludge return as well as the aeration process.

**Total aeration capacity, includes both contact and reaeration capacities. Normally the contact zone equals thirty to thirty-five percent (30%–35%) of the total aeration capacity.

2. Arrangement of aeration tanks.

A. General tank configuration.

(I) Dimensions. The dimensions of each independent mixed liquor aeration tank or return sludge reaeration tank shall be so as to maintain effective mixing and utilization of air. Ordinarily, liquid depths should not be less than ten feet (10') (3m) or more than thirty feet (30') (9m) except in special design cases.

(II) Short-circuiting. For very small tanks or tanks with special configuration, the shape of the tank and the installation of aeration equipment should provide the positive control of short-circuiting through the tank.

B. Number of units. Total aeration tank volume required shall be divided among two (2) or more units, capable of independent operation, when required by the agency to meet applicable effluent limitations and reliability guidelines.

C. Inlets and outlets.

(I) Controls. Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, stop plates, weirs or other devices to permit controlling the flow to any unit and to maintain reasonably constant liquid level. The hydraulic properties of the system shall permit the maximum instantaneous hydraulic load to be carried with any single aeration tank unit out-of-service.

(II) Conduits. Channels and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleansing velocities or shall be agitated to keep the solids in suspension at all rates of flow within the design limits. Adequate provisions should be made to drain segments of channels which are not being used due to alternate flow patterns.

D. Freeboard. All aeration tanks should have a freeboard of not less than eighteen inches (18") (46 cm). Additional freeboard or windbreak may be necessary to protect against freezing or wind blown spray.

3. Aeration equipment.

A. General. Oxygen requirements generally depend on maximum diurnal organic loading, degree of treatment and level of suspended solids concentration to be maintained in the aeration tank mixed liquor. Aeration equipment shall be capable of maintaining a minimum of two (2.0) mg/l of dissolved oxygen in the mixed liquor at all times and providing thorough mixing of the mixed liquor. In the absence of experimentally determined values, the design oxygen requirements for all activated sludge processes shall be 1.1 lbs. O_2/lb. peak BOD_5 applied to the aeration tanks (1.1 kg O_2/kg peak BOD_5) except the value of 1.8 shall be used for the extended aeration process. In the case of nitrification, the oxygen requirement for oxidizing ammonia must be added to the above requirement for carbonaceous BOD_5 removal. The nitrogen oxygen demand (NOD) shall be taken as 4.6 times the diurnal peak total kjeldahl nitrogen (TKN) content of the influent. In addition, the oxygen demands due to recycle flows—heat treatment supernatant, vacuum filtrate, elutriates, etc., must be considered due to the high concentration of BOD_5 and TKN associated with the flows. Careful consideration should be given to maximizing oxygen utilization per unit power input. Unless flow equalization is provided, the aeration system should be designed to match the diurnal organic load variation while economizing on power input.

B. Diffused air systems. The desire of the diffused air system to provide the oxygen requirements shall be done by either of the following two (2) methods.

(I) Having determined the oxygen requirements per subparagraph (4)(C)3.A. of this rule, air requirements for a diffused air system shall by use of any of the well known equations incorporate such factors as tank depth, alpha factor of waste, beta factor of waste, certified aeration device transfer efficiency, minimum aeration tank dissolved oxygen concentrations, critical wastewater temperature and altitude of plant. In the absence of experimentally determined alpha and beta factors, wastewater transfer efficiency shall be assumed to be fifty percent (50%) of clean water efficiency for plants treating primarily ninety percent (90%) or greater domestic sewage. Treatment plants where the waste contains higher percentages of industrial wastes shall use a correspondingly lower percentage of clean water efficiency and shall have calculations submitted to justify such a percentage.

(II) Normal air requirements for all activated sludge processes except extended aeration (assuming equipment capable of transmitting to the mixed liquor the amount of oxygen required in subparagraph (4)(C)3.A.) shall be considered to be fifteen hundred (1500) cu.ft. per pound of BOD_5 peak aeration tank loading (93.5m^3/kg of BOD_5). For the extended-aeration process the value shall be two thousand (2000) cu. ft. (125m).

(III) To the air requirements calculated in part (4)(C)3.B.(II) of this rule shall be added air required for channels, pumps, aerobic digesters or other air-use demand.

(IV) The specified capacity of blowers or air compressors, particularly centrifugal blowers, should take into account that the air intake temperature may reach forty degrees Celsius (40°C) (one hundred four degrees Fahrenheit (104°F)) or higher and the pressure may be less than normal. The specified capacity of the motor drive should also take into account that the intake air may be minus thirty degrees Celsius (-30°C) (minus twenty-two degrees Fahrenheit (-22°F)) or less and may require oversizing of the motor or a means of reducing the rate of air delivery to prevent overheating or damage to the motor.

(V) The blowers shall be so provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out-of-service. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the plant. Aeration equipment shall be easily adjustable in increments and shall maintain solids suspension within these limits.

(VI) Diffuser systems shall be capable of providing for the diurnal peak oxygen demand or two hundred percent (200%) of the design average oxygen demand whichever is larger. The air diffusion piping and diffuser system shall be capable of delivering normal air requirements with minimal friction losses. Air piping systems should be designed such that total head loss from blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 pounds per square inch (psi) (0.04 kgf/cm^2) at average operating conditions. The spacing of diffusers should be in accordance with the oxygen requirements within the channel or tank, and should be designed to facilitate adjustment of their spacing without major revision to air header piping. All plants employing less than four (4) independent aeration tanks shall be designed to incorporate removable diffusers that can be serviced and/or replaced without de-watering the tank.

(VII) Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling or for complete shutoff. Diffusers in any single assembly shall have substantially uniform pressure loss.

(VIII) Air filters shall be provided in numbers, arrangements and capacities to furnish at all times an air supply sufficiently free from dust to prevent damage to blowers and clogging of the diffuser system used.

C. Mechanical aeration systems.

(I) Oxygen transfer performance. The mechanism and drive unit shall be designed for the expected conditions in the aeration tank in terms of the power performance. Certified testing shall verify mechanical aerator performance.

(II) Design requirements. The design requirements of a mechanical aeration system shall accomplish the following: maintain a minimum of two (2.0) mg/l of dissolved oxygen in the mixed liquor at all times throughout the tank or basin; maintain all biological solids in suspension; meet maximum oxygen demand and maintain process performance with the largest unit out-of-service; and provide for varying the amount of oxygen transferred in proportion to the load demand on the plant.

(III) Winter protection. Due to high heat loss, the mechanism as well as subsequent treatment units shall be protected from freezing where extended cold weather conditions occur.

(D) Return Sludge Equipment.

1. Return sludge rate. The minimum permissible return sludge rate of withdrawal from the final settling tank is a function of the concentration of suspended solids in the mixed liquor entering it, the sludge volume index of these solids and the length of time these solids are retained in the settling tank. Since undue retention of solids in the final settling tanks may be deleterious to both the aeration and sedimentation phases of the activated sludge process, the rate of sludge return

expressed as a percentage of the average design flow of sewage should generally be variable between the limits set forth as follows:

	Minimum	Maximum
Standard Rate	15	75
Carbonaceous Stage of Separate Stage Nitrification	15	75
Step Aeration	15	75
Contact Stabilization	50	150
Extended Aeration	50	150
Nitrification Stage of Separate Stage Nitrification	50	200

The rate of sludge return shall be varied by means of variable speed motors, drives or times (small plants) to pump sludge at the rates mentioned in the previous table.

2. Return sludge pumps. If motor driven return sludge pumps are used, the maximum return sludge capacity shall be obtained with the largest pump out-of-service. A positive head should be provided on pump suctions. Pumps should have at least three-inch (3") (7.6 cm) suction and discharge openings. If air lifts are used for returning sludge from each settling tank hopper, no standby unit will be required provided the design of the air lifts are so as to facilitate their rapid and easy cleaning and provided other suitable standby measures are provided. Air lifts should be at least three inches (3") (7.6 cm) in diameter.

3. Return sludge piping. Discharge piping should be at least four inches (4") (10 cm) in diameter and should be designed to maintain a velocity of not less than two feet (2') per second (0.61m/s) when return sludge facilities are operating at normal return sludge rates. Suitable devices for observing, sampling and controlling return activated sludge flow from each settling tank hopper shall be provided.

4. Waste sludge facilities. Waste sludge control facilities should have a maximum capacity of not less than twenty-five percent (25%) of the average rate of sewage flow and function satisfactorily at rates of 0.5 percent of average sewage flow or a minimum of ten (10) gallons per minute (0.63 l/s), whichever may be the larger. Means for observing, measuring, sampling and controlling waste activated sludge flow shall be provided. Waste sludge may be discharged to the concentration or thickening tank, primary settling tank, sludge digestion tank, vacuum filters or any practical combination of these units.

(E) Measuring Devices. Devices should be installed in all plants for indicating flow rates of raw sewage or primary effluent, return sludge and air to each tank unit. For plants designed for sewage flows of 1 mgd ($3785m^3/d$) or more, these devices should totalize and record, as well as, indicate flows. Where the design provides for all return sludge to be mixed with the raw sewage (or primary effluent) at one (1) location, then the mixed liquor flow rate to each aeration unit should be measured.

(5) Rotating Biological Contactors.

(A) General.

1. Applicability. The rotating biological contactor (RBC) process may be used where sewage is amenable to biological treatment. The process may be used to accomplish carbonaceous and/or nitrogenous oxygen demand reductions. Design standards, operating data and experience for this process are not well established. Therefore, expected performance of RBCs shall be based upon experience to similar full scale installations or thoroughly documented pilot testing with the particular wastewater.

2. Winter protection. Wastewater temperature affects rotating contactor performance. Year round operation in colder climates requires that rotating contactors be covered to protect the biological growth from cold temperatures and the excessive loss of heat from the wastewater with the resulting loss of performance. Enclosures shall be constructed of a suitable corrosion-resistant material. Windows or simple louvered mechanisms which can be opened in the summer and closed in the winter shall be installed to provide adequate ventilation. To minimize condensation, the enclosure should be adequately insulated and/or heated.

(B) Required Pretreatment. RBC's must be preceded by effective settling tanks equipped with scum and grease collecting devices unless substantial justification is submitted for other pretreatment devices which provide for effective removal of grit, debris and excessive oil or grease prior to the RBC units. Bar screening or comminution are not suitable as the sole means of pretreatment.

(C) Unit Sizing. Unit sizing shall be based on experience at similar full-scale installations or thoroughly documented pilot testing with the particular wastewater. In determining design loading rates, expressed in units of volume per day per unit area of media covered by biological growth, the following parameters must be considered: design flow rate and influent waste strength; percentage of BOD_5 to be removed; media arrangement including number of stages and unit area in each stage; rotational velocity of the media; retention time within the tank containing the media; and wastewater temperature; and the percentage of influent BOD_5 which is soluble. In addition to these parameters, loading rates for nitrification will depend upon influent TKN, pH and the allowable effluent ammonia nitrogen concentration.

(D) Design Safety Factor. Effluent concentrations of ammonia nitrogen from the RBC process designed for nitrification are affected by diurnal load variations. Therefore, it may be necessary to increase the design surface area proportional to the ammonia nitrogen diurnal peaking rates appropriately to meet effluent limitations. An alternative is to provide flow equalization sufficient to insure process performance within the required effluent limitations.

(6) Other Biological Systems. New biological treatment schemes with promising applicability in wastewater treatment may be considered if the required engineering data for new process evaluation is provided in accordance with 10 CSR 20-8.140(5)(B).

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.190 Disinfection

PURPOSE: The following criteria have been prepared as a guide for the design of disinfection facilities. This rule is to be used with rules 10 CSR 20-8.110–10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers **Recommended Standards for Sewage Works** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or* *supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred gallons per day (22,500 gpd) ($85.4m^3$) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) Forms of Disinfection. Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid chlorine and calcium or sodium hypochlorite. Other disinfectants, including chlorine dioxide, ozone or bromine, may be accepted by the agency in individual cases. The chemical should be selected after due consideration of waste flow rates, application and demand rates, pH of the wastewater, cost of equipment, chemical availability and maintenance problems. If chlorination is utilized, it may be necessary to dechlorinate if the chlorine level in the effluent would impair the natural aquatic habitat of the receiving stream.

(4) Feed Equipment.

(A) Type. Solution-feed vacuum-type chlorinators are generally preferred for large chlorination installations. The use of hypochlorite feeders of the positive displacement type may be considered and are generally preferred when intermittent disinfection is required. The preferred method of generation of chlorine dioxide is the injection of a sodium chlorite solution into the discharge line of a solution-feed gas-type chlorinator with subsequent formation of the chlorine dioxide in a reaction chamber at a pH of four (4.0) or less. Ozone dissolution is accomplished through the use of conventional gas diffusion equipment, with appropriate consideration of materials. If ozone is being produced from air, gas preparation equipment (driers, filters, compressors) is required. If ozone is being produced from oxygen, this equipment may not be needed as a clean dry pressurized gas supply will be available.

(B) Control.

1. Chlorination without dechlorination. Facilities with design flows of one million gallons per day (1.0mgd) ($3785m^3/d$) or greater shall be equipped with a chlorine rate control to feed the chlorine proportional to the flow of wastewater and the chlorine residual. Facilities with design flows between one (1.0) mgd ($3785m^3/d$) and twenty-two thousand five hundred (22,500) gpd ($85.4m^3$) should be equipped with a control system to feed the chlorine proportional to the flow of wastewater.

2. Chlorination with dechlorination. All facilities designed for dechlorination must be equipped to feed the chlorine proportional to the flow of wastewater and the chlorine residual. Dechlorination equipment shall be equipped to feed in proportion to the flow of wastewater.

3. Ozone. Facilities for disinfection with ozone should be equipped to feed the ozone in proportion to the flow of wastewater.

(C) Capacity. Required disinfection capacity will vary, depending on the uses and points of application of the disinfecting chemical. For disinfection, the capacity should be adequate to produce an effluent that will meet the coliform limits specified by the agency. For normal domestic sewage, the following may be used as a guide in sizing chlorination facilities.

Type of Treatment	Dosage
Trickling filter plant	10 mg/l
Activated sludge plant effluent	8 mg/l
Tertiary filtration effluent	6 mg/l
Nitrified effluent	6 mg/l

(D) Standby Equipment and Spare Parts. Standby equipment of sufficient capacity should be available to replace the largest unit during shutdowns. Spare parts shall be available for all disinfection equipment to replace parts which are subject to wear and breakage.

(E) Water Supply. An ample supply of water shall be available for operating the chlorinator. Where a booster pump is required, duplicate equipment should be provided and when necessary, standby power as well. Protection of a potable water supply shall conform to the requirements of 10 CSR 20-8.140(8)(B).

(5) Chlorine Supply.

(A) General. The type of chlorine supply should be carefully evaluated during the planning process. Large quantities of chlorine are contained in ton cylinders and tank cars can present a considerable hazard to plant personnel and to the surrounding area should the containers develop leaks.

(B) Containers. The use of ton containers should be considered where the average daily chlorine consumption is over one hundred fifty pounds (150 lbs.) (68 kg). Both monetary cost and the potential residential exposure to chlorine should be considered when making the final determination.

(C) Tank Cars. At large chlorination installations consideration should be given to the use of tank cars, generally accompanied by gas evaporators. Both monetary cost and the potential residential exposure to chlorine should be considered when making the final determination. Liquid chlorine lines from tank cars to evaporators shall be buried and installed in a conduit and shall not enter below grade spaces. Systems shall be designed for the shortest possible pipe transportation of liquid chlorine.

(D) Scales. Scales for weighing cylinders shall be provided at all plants using chlorine gas. At large plants, scales of the indicating and recording type are recommended. At least a platform scale shall be provided. Scales shall be of corrosion-resistant material.

(E) Evaporators. Where manifolding of several cylinders or ton containers will be required to evaporate sufficient chlorine, consideration should be given to the installation of evaporators, to produce the quantity of gas required.

(F) Leak Detection and Controls. A bottle of fifty-six percent (56%) ammonium hydroxide solution shall be available for detecting chlorine leaks. Where ton containers or tankcars are used, a leak repair kit approved by the Chlorine Institute shall be provided. Consideration should be given to the provision of caustic soda solution reaction tanks for absorbing the contents of leaking ton containers where the containers are in use. At large chlorination installations, consideration should be given to the installation of automatic gas detection and related alarm equipment. For ozone installations, similar purpose equipment shall be provided.

(6) Ozone Generation. Ozone may be produced from either an air or an oxygen gas source. Generation units shall be automatically controlled to adjust ozone production to meet disinfection requirements.

(7) Piping and Connections. Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for chlorine or ozone service, with a minimum number of joints. Piping should be well supported and protected against temperature extremes. The correct weight or thickness of steel is suitable for use with dry chlorine liquid or gas. Even minute traces of water added to chlorine results in a corrosive attack that can only be resisted by pressure piping utilizing materials such as silver, gold, platinum or Hasteloy C. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinylchloride (PVC) or Uscolite materials are satisfactory for wet chlorine or aqueous solutions of chlorine. Due to the corrosiveness of wet chlorine, all lines designed to handle dry chlorine should be protected from the entrance of water or air containing water. For ozonation systems, the selection of material should be made with due consideration for ozone's corrosive nature. Copper or aluminum alloy should be avoided. Stainless steel with a corrosion resistance of at least equal to grade 304 L should be specified for piping containing ozone in nonsubmerged applications. Unplasticized PVC, Type 1, may be used in submerged piping, provided the gas temperature is below one hundred forty degrees Fahrenheit (140°F) (60°C) and the gas pressure is low.

(8) Housing.

(A) Separation. If gas chlorination equipment, chlorine cylinders or ozone generation equipment are to be in a building used for other purposes, a gas-tight room shall separate this equipment from any other portion of the building. Floor drains from the chlorine room should not be connected to floor drains from other rooms. Doors to this room shall open only to the outside of the building and shall be equipped with panic hardware. The rooms shall be at ground level and should permit easy access to all equipment. Storage area should be separate from the feed area. Chlorination equipment should be situated as close to the application point as reasonably possible.

(B) Inspection Window. A clear glass, gas-tight window shall be installed in an exterior door or interior wall of the chlorinator or ozone generator room to permit the units to be viewed without entering the room.

(C) Heat. Rooms containing disinfection equipment shall be provided with a means of heating so that a temperature of at least sixty degrees Fahrenheit (60°F) (16°C) can be maintained but the room should be protected from excess heat. Cylinders shall be kept at essentially room temperature. The room containing the ozone generation units shall be maintained above thirty-five degrees Fahrenheit (35°F) (2°C) at all times.

(D) Ventilation. With chlorination systems, forced, mechanical ventilation shall be installed which will provide one (1) complete air change per minute when the room is occupied. For ozonation systems, continuous ventilation to provide at least six (6) complete air changes per hour should be installed. The entrance to the air exhaust duct from the room shall be near the floor and the point of discharge shall be so located as not to contaminate the air inlet to any buildings or inhabited areas. Air inlets shall be so located as to provide cross ventilation with air and at a temperature that will not adversely affect the chlorination of ozone generation equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade.

(E) Electrical Controls. Switches for fans and lights shall be outside of the room at the entrance. A labeled signal light indicating fan operation should be provided at each entrance, if the fan can be controlled from more than more one (1) point.

(9) Respiratory Protection. Respiratory air-pac protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) shall be available where chlorine gas is handled and shall be stored at a convenient location but not inside any room where chlorine is used or stored. Instructions for using, testing and replacing mask parts including canisters, shall be posted adjacent to the equipment. The units shall use compressed air, have at least thirty (30)-minute capacity and be compatible with the units used by the fire department responsible for the plant.

(10) Application of Chlorine or Ozone.

(A) Mixing. The disinfectant shall be positively mixed as rapidly as possible, with a complete mix being effected in three (3) seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer.

(B) Contact Period. For a chlorination system, a minimum contact period of fifteen (15) minutes at peak hourly flow or maximum rate of pumpage shall be provided after thorough mixing. Consideration should be given to running a field tracer study to assure adequate contact time. If dechlorination is required after complete mixing of the effluent with the chemical, no further contact time is necessary. The required contact time for an ozonation unit varies with the type of dissolution equipment used. Certain high rate devices require contact times less than one (1) minute to achieve disinfection while conventional dissolution equipment may require contact times similar to chlorination systems.

(C) Contact Tank. The chlorine or ozone contact tank shall be constructed so as to reduce short-circuiting of flow to a practical minimum. Baffles shall be parallel to the longitudinal axis of the chamber with a minimum length to width ratio of forty to one (40:1) (the total length of the channel created by the baffles should be forty (40) times the distance between the baffles). The tank should be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection. Duplicate tanks, mechanical scrapers or portable deck level vacuum cleaning equipment shall be provided. Consideration should be given to providing skimming devices on all contact tanks. Covered tanks are discouraged.

(11) Evaluation of Effectiveness.

(A) Sampling. Facilities shall be included for sampling the disinfected effluent after contact. In large installations, or where stream conditions warrant, provisions should be made for continuous monitoring of effluent chlorine residual.

(B) Testing. Equipment shall be provided for measuring chlorine residuals using accepted test procedures. Automatic equipment required by subsection (4)(C) of this rule may be used to meet the requirements of this subsection. Equipment shall also be required for measuring fecal coliform using accepted test procedures as required by 10 CSR 20-9.010.

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.200 Wastewater Treatment Ponds (Lagoons)

PURPOSE: The following criteria have been prepared as a guide for the design of wastewater treatment ponds (lagoons). This rule is to be used with rules 10 CSR 20-8.110–10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule *reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers* ***Recommended Standards for Sewage Works*** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

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(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons per day ($85.4m^3$) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) General. This rule deals with generally used variations of treatment ponds to achieve secondary treatment including controlled discharge pond systems, flow-through pond systems and aerate pond systems. Ponds utilized for equalization, percolation, evaporation and sludge storage will not be discussed in this rule.

(4) Supplement to Engineer's Report. The engineer's report shall contain pertinent information on location, geology, soil conditions, area for expansion and any other factors that will affect the feasibility and acceptability of the proposed project. The following information must be submitted in addition to that required in 10 CSR 20-8.110.

(A) Supplementary Field Survey Data.

1. The location and direction of all residences, commercial developments, parks, recreational areas and water supplies, including a log of each well if available within one-half (1/2) mile (0.8 km) of the proposed pond shall be included in the engineer's report.

2. Land use zoning adjacent to the proposed pond site shall be included.

3. A description, including maps showing elevations and contours, of the site and adjacent area shall be provided. Due consideration shall be given to additional treatment units and/or increased waste loadings in determining land requirements. Current United States Geological Survey and Soil Conservation Service maps may be considered adequate for preliminary evaluation of the proposed site.

4. The location, depth and discharge point(s) of any field tile in the immediate area of the proposed site shall be identified.

5. A geological evaluation of the proposed lagoon site prepared by the Division of Geology and Land Survey (DGLS) shall be submitted. To obtain this geological evaluation of the proposed site, the engineer shall submit the following information to the Department of Natural Resources, Division of Geology and Land Survey, P.O. Box 250, Rolla, MO 65401:

A. A layout sheet showing the proposed location. The layout shall include the legal description, property boundaries, roads, streams and other geographical landmarks which will assist in locating the site;

B. Size of the lagoon and/or approximate volume of waste to be treated;

C. Maximum cuts to be made in the construction of the lagoon; and

D. Location and depth of cut for borrow area, if any.

6. Sulfate content of the primary water supply shall be determined.

7. Data from all soil borings conducted by a professional soil testing laboratory to determine subsurface soil characteristics and groundwater characteristics, including elevation, at the proposed site and their effect on the construction and operation of a pond shall also be provided. All boring holes shall be filled and sealed. The permeability characteristics of the pond bottom and pond seal material shall also be studied. At the facility plan stage particle size analysis, Atterburg limits, standard Procter density (moisture-density relations) or permeability coefficient may be required on a case-by-case basis to reflect soil characteristics. At the twenty percent (20%) design stage, soil analysis of each representative soil material including particle size analysis, Atterburg limits, standard Procter density (moisture-density relations) and permeability coefficient of the compacted soil as measured in a falling head permeameter or other text procedure acceptable to the agency may be required. Soil borings may be required in each geological area to determine depth to piezometric surface and to bedrock. Recommendations of the DGLS will be used to establish the required tests at the facility plan and twenty percent (20%) design stages.

(B) Site Information.

1. Distance from habitation. Lagoon sites should be as far as practicable from habitation or any area which may be built up within a reasonable future period. The agency does not attempt to set any minimum distance from habitation since each case must be judged upon its own merits.

2. Prevailing winds. If practicable, ponds should be located so that local prevailing winds will be in the direction of uninhabited areas.

3. Surface runoff. Location of ponds in watersheds receiving significant amounts of stormwater runoff is discouraged. Adequate provisions must be made to divert stormwater runoff around the ponds and protect embankments from erosion.

4. Hydrology. Construction of ponds in close proximity to water supplies and other facilities subject to contamination should be avoided. A minimum separation of four feet (4') (1.2m) between the bottom of the pond and the maximum groundwater elevation should be maintained where feasible.

5. Groundwater pollution. Proximity of lagoons to water supply located in areas of porous soils and fissured rock formation shall be elevated to avoid creation of health hazards or other undesirable conditions. If the geological report from DGLS makes suggestions for remedial treatment of the site, the engineer shall comply with the suggestions. In some cases, the engineering geologist requests to visit the site during or after construction. When a request is made, the consulting engineer shall comply with the request.

(5) Basis of Design.

(A) Quality of Effluent. A controlled discharge stabilization pond (four (4)-cell) will be considered capable of meeting effluent limitations of thirty (30) mg/l biochemical oxygen demand (BOD_5) and thirty (30) mg/l suspended solids. Flow-through stabilization ponds (three (3)-cell), and aerated lagoon systems will be considered capable of meeting effluent limitations of thirty (30) mg/l BOD" and eighty (80) mg/l suspended solids. Flow-through lagoon systems and aerated lagoon systems followed by submerged sand filters will be considered capable of meeting effluent limitations of twenty (20) mg/l BOD_5 and twenty (20) mg/l suspended solids. Lagoons may be incorporated into irrigation systems or systems utilizing chemical coagulation and filtration to meet the requirements of 10 CSR 20-7.015(3)(A)3. Please refer to 10 CSR 20-7.015 Effluent Regulation for discharge requirements.

(B) Area and Loadings for Controlled Discharge Stabilization Ponds (four (4)-cell). Pond design for BOD_5 loadings shall not exceed thirty-four (34) lbs./acre/day (38 km per hectare per day) at the three-foot (3'-1.9m) operating depth in the primary cells. The primary cell shall be followed by a secondary cell having 0.3 the area of the primary cell and by two (2) storage cells. The two (2) storage cells shall have a volume above the two-foot (2'-0.6m) level for one (1) month's storage of average daily flow in each cell. At least one hundred twenty (120) days' detention time between the two-foot (2') level (0.6m) and the maximum operating depth shall be provided in the entire pond system. Flow can be based on one hundred (100) gallons per capita per day ($38m_3$/cap/d) or other values if data is presented to justify the rate. Primary and secondary cells shall be designed for water depths up to a maximum of five feet (5') (1.5m). The storage cell should be made as deep as possible up to a maximum depth of eight feet (8') (2.4m).

(C) Area and Loadings for Flow-through Stabilization Ponds (three (3) cell). Pond design for BOD_5 loadings shall not exceed thirty-four (34) pounds per acre per day (38 km per hectare per day). The second cell must be at least 0.3 the area of the first cell and the third cell 0.1 the area of the first cell. The first and second cells must have a variable operating level of between two feet (2') (0.6m) and five feet (5') (1.5m). The third cell must have a variable operating level of between two feet (2') (0.6m) and eight feet (8') (2.4m). Detention time of at least one hundred twenty (120) days must be provided. Flows of less than one hundred (100) gallons per capita per day ($.38m^3$/cap/d) may be used if data is presented to justify the lower rate.

(D) Aerated Lagoons. For the development of final design parameters it is recommended that actual experimental data be developed; however, the aerated lagoon design for minimum detention time may be estimated using the following formula:

$$t = \frac{E}{2.3\,K_1 \times (100\text{-}E)}$$

where:
t = detention time in the aeration cell in days;
E = percent of BOD_5 to be removed in an aerated pond; and
K_1 = reaction coefficient aerated lagoon, base 10.

For normal domestic sewage the K_1 value may be assumed to be .15 per day for Missouri conditions. The reaction rate coefficient for domestic sewage which includes some industrial waste, other waste or partially treated sewage must be determined experimentally for various conditions which might be encountered in the aerated ponds. Conversion of the reaction coefficient at other temperatures shall be based on experimental data. Raw sewage strength should also consider the effect of any return sludges. Also, additional storage volume should be considered for sludge and in northern climates, ice cover. Oxygen requirements generally will depend on the BOD_5 loading, the degree of treatment and the concentration of suspended solids to be maintained. Aeration equipment shall be capable of maintaining a minimum dissolved oxygen level of two (2) mg/l in the ponds at all times. Suitable protection from weather shall be provided for electrical controls. The aeration equipment shall be capable of providing 1.3 pounds of oxygen per pound of BOD_5(1.3 kg/kg BOD_5) removed. BOD_5 removal shall be based on warm weather rates. Aerated cells shall be followed by a polishing cell with a volume of 0.3 of the volume of the aerated cell (see 10 CSR 20-8.180 for details on aeration equipment).

(E) Multiple Units. Parallel cells should be considered for large installations. The maximum size of any cell should be forty (40) acres (16 ha). The system should be designed to permit isolation of any cell without disrupting service of the other cells.

(F) Pond Shape. The shape of all cells should be so that there are no narrow or elongated portions. Round, square or rectangular ponds with a length not exceeding three (3) times the width are considered most desirable. No islands, peninsulas or coves shall be permitted. Dikes should be rounded at corners to minimize accumulation of floating materials. Common dike construction, wherever possible, is strongly encouraged.

(G) Industrial Wastes. Consideration shall be given to the type and effects of industrial wastes on the treatment process. In some cases it may be necessary to pretreat industrial or other discharges. Industrial wastes shall not be discharged to ponds without assessment of the effects the substances may have upon the treatment processor discharge requirements in accordance with state and federal laws.

(H) Additional Treatment. Consideration should be given in the design stage to the utilization of additional treatment units as may be necessary to meet applicable discharge standards (see paragraph (4)(A)3. of this rule).

(6) Pond Construction Details.

(A) Embankments and Dikes.

1. Material. Dikes shall be constructed of relatively impervious material and compacted to at least ninety-five percent (95%) standard Procter density to form a stable structure. Vegetation and other unsuitable materials shall be removed from the area where the embankment is to be placed.

2. Top width. The minimum dike width shall be eight feet (8') (2.4m) to permit access of maintenance vehicles.

3. Maximum slopes. Inner and outer dike slopes shall not be steeper than three horizontal to one vertical (3:1).

4. Minimum slopes. Inner slopes should not be flatter than four horizontal to one vertical (4:1). Flatter slopes can be specified for larger installations because of wave action but have the disadvantage of added shallow areas being conducive to emergent vegetation. Outer slopes shall be sufficient to prevent surface runoff from entering the ponds.

5. Freeboard. Minimum freeboard shall be two feet (2') (0.6m). For very large cells, three feet (3') (1.0m) should be considered.

6. Design depth. The minimum operating depth should be sufficient to prevent growth of aquatic plants and damage to the dikes, bottom, control structures, aeration equipment and other appurtenances. In no case should pond depths be less than two feet (2') (0.6m). The design water depth for aerated lagoons should be ten to fifteen feet (10–15') (3–4.5m). This depth limitation may be altered depending on the aeration equipment, waste strength, climatic conditions and geologic conditions.

7. Erosion control. A justification and detailed discussion of the method of erosion control which encompasses all relative factors such as pond location and size, variations in operating depths, seal material, topography, prevailing winds, cost breakdown, application procedures, etc., shall be provided.

A. Seeding. The dikes shall have a cover layer of fertile topsoil with a minimum thickness of four inches (4") (10 cm) to promote establishment of an adequate vegetative cover wherever riprap is not utilized. Prior to prefilling (in accordance with paragraph (6)(C)3. of this rule), adequate vegetation shall be established on dikes from the outside toe to one foot (1') above the water line measured on the slope. Perennial-type, low growing, spreading grasses that minimize erosion and can be mowed are most satisfactory for seeding of dikes. In general, alfalfa and other long-rooted crops should not be used for seeding since the roots of this type are apt to impair the water holding efficiency of the dikes. Alternate dike stabilization practices may be considered if vegetative cover cannot be established prior to prefilling.

B. Additional erosion protection. Riprap or some other acceptable method of erosion control is required as a minimum around all piping entrances and exits. For aerated cell(s) design should ensure erosion protection on the slopes and bottoms in the areas where turbulence will occur. Additional erosion control may also be necessary on the exterior dike slope(s) to protect the embankment(s) from erosion due to severe flooding of a water course.

C. Alternate erosion protection. Alternate erosion control on the interior dike slopes may be necessary for ponds which are subject to severe wave action. In these cases riprap or an acceptable equal shall be placed from one foot (1') (.3m) above the high water mark to two feet (2') (0.6m) below the low water mark (measured on the vertical). This protection should also be provided in the storage cells of a controlled discharge (four (4)-cell) pond and the third cell of a flow-through pond (three (3)-cell) where large fluctuations in operating depths will occur.

(B) Pond Bottom.

1. Soil. Soil used in constructing the pond bottom (not including the seal) and dike cores shall be selected to avoid settlement. Soil shall be compacted with the moisture content between two percent (2%) below and four percent (4%) above the optimum water content and to the specified standard Procter density but no less than ninety-five percent (95%) standard Procter density.

(C) Seal.

1. Design. Ponds shall be sealed so that seepage loss through the seal is as low as practicably possible. Seals consisting of soils or synthetic liners may be used provided the permeability, durability, integrity and cost effectiveness of the proposed materials can be satisfactorily demonstrated for anticipated conditions. Bentonite, soda ash or other sealing aids may be used to achieve an adequate seal in systems using soil. Results of a testing program which substantiates the adequacy of the proposed seal must be incorporated into and/or accompany the engineering report. Standard ASTM procedures or other acceptable methods shall be used for all tests. Soils having a permeability coefficient of 10-cm/sec or less with a compacted thickness of twelve inches (12") (30.5 cm) will be acceptable as a lagoon seal for water depths up to five feet (5') (1.5m). For permeability coefficients greater than 10-- cm/sec or for heads over five feet (5') (1.5m) such as an aerated lagoon system, the following formula shall be used to determine minimum seal thickness:

$$t = \frac{H \times K}{5.4 \times 10^{-7} \text{ cm/sec}}$$

where:

K = the permeability coefficient of the soil in question;

H = the head of water in the lagoon; and

t = the thickness of the soil seal.

Units for H and t may be English or metric; however, they must be the same. For a seal consisting of an artificial liner, seepage loss shall not exceed the equivalent of the rate expressed in this paragraph.

2. Normal construction methods will include over-excavation below grade level of twelve inches (12") (30.5 cm), scarification and compaction of base material to ninety-five percent (95%) standard Procter density at moisture content between two percent (2%) below and four percent (4%) above optimum, and compaction of lifts generally not exceeding six inches (6") (15.2 cm) to ninety-five percent (95%) standard Procter density at moisture content between two percent (2%) below and four percent (4%) above optimum. Maximum rock size should not exceed one-half (1/2) of the thickness of the compacted lift. The cut face of dikes must also be over-excavated and compacted in lifts not to exceed six inches (6") (15.2 cm) per lift. Soils containing plastic clay may be excluded from this construction requirement on a case-by-case basis based on particle size analysis and Atterburg limits. In fact, with some clay soils, satisfactory construction cannot be obtained by over-excavation and recompaction. Construction control must include field density. A minimum of two (2) density tests per acre or not less than three (3) tests must be performed for the base and each lift. Permeability tests of field compacted material may be performed at the option of the consulting engineer.

3. Prefilling. The pond shall be prefilled in order to protect the liner, to prevent weed growth, to reduce odor, to allow measurement of percolation losses and to maintain moisture content of the seal. However, the dikes must be completely prepared as described in subparagraphs (6)(A)7.A. and/or B. of this rule before the introduction of water. If the lagoon bottom is allowed to dry, the seal must be recompacted as required in paragraph (6)(C)2.

4. Percolation losses. Measurement of percolation losses shall consider flow into and out of the lagoon, rainfall and evaporation, and changes in water level. Measured percolation losses in excess of one-sixteenth inch (1/16") (1.6 mm) per day will be considered excessive.

(D) Influent Lines.

. Material. Cast- or ductile-iron pipe should be used for the influent line to the pond. Unlined corrugated metal pipe should be avoided due to corrosion problems. Other materials selected shall be suited to local conditions. In material selection, consideration must be given to the quality of the wastes, exceptionally heavy external loadings, abrasion, soft foundations and similar problems.

2. Manhole. A manhole shall be installed prior to entrance of the influent line into the primary cell(s) and shall be located as close to the dike as topography permits. Its invert shall be at least six inches (6") (15 cm) above the maximum operating level of the pond and provide sufficient hydraulic head without surcharging the manhole.

3. Flow distribution. Flow distribution structures shall be designed to effectively split hydraulic and organic loads equally to the primary cells.

4. Influent line(s). The influent line(s) shall be located along the bottom of the pond so that the top of the pipe is just below the average elevation of the pond seal; however, the pipe shall have adequate seal below it.

5. Point of discharge. All primary cells shall have individual influent line(s) which terminate at approximately the center of the cell so as to minimize short-circuiting. Consideration should be given to multi-influent discharge points for primary cells of twenty (20) acres (8 hectares) or larger to enhance distribution of the waste load on the cell. All aerated cells shall have influent lines which distribute the load within the mixing zone of the aeration equipment. Consideration of multi-inlets should be closely evaluated for any diffused aeration systems.

6. Influent discharge apron. The influent line(s) shall discharge horizontally into the shallow saucer-shaped depression. The end of the discharge line(s) shall rest on a suitable concrete apron large enough so that the terminal influent velocity at the end of the apron does not cause soil erosion. A minimum size apron of two feet (2') (0.6m) square shall be provided.

(E) Control Structures and Interconnecting Piping.

1. Structure. Facilities design shall consider the use of multipurpose control structures, where possible, to facilitate normal operational functions such as drawdown and flow distribution, flow and depth measurement, sampling, pumps for recirculation, chemical additions and mixing and to minimize the number of construction sites within the dikes. As a minimum, control structures shall be accessible for maintenance and adjustment of controls; adequately ventilated for safety and to minimize corrosion; locked to discourage vandalism; contain controls to allow water level and flow rate control, complete shut off and complete draining; constructed of noncorrosive materials (metal on metal contact in controls should be of like alloys to discourage electrochemical reactions); and located to minimize short-circuiting within the cell and avoid freezing and ice damage. Recommended devices to regulate the water level are valves, slide tubes or dual slide gates. Regulators should be designed so that they can be preset to stop flows at any pond elevation.

2. Piping. All piping shall be of cast-iron or other acceptable materials. The piping should not be located within the seal. Seep collars shall be provided on drain pipes where they pass through the pond seal. Backfill around the drain pipe shall be placed and compacted in the same manner as the pond seal. Pipes should be anchored with adequate erosion control.

A. Drawdown structure piping.

(I) Multilevel outlets. The outlet structure on each pond cell, except aerated cells, shall be designed to permit overflow at one-foot (1') (30.5 cm) increments between the two foot (2'-61 cm) level and the maximum operating level. Suitable baffling shall be provided to prevent discharge of scum or other floating materials. Means must be provided to prevent unauthorized variance of the lagoon depth. A flap valve shall be provided at the outlet end of the final cell overflow or drain pipe to prevent entrance of animals or backwater from flooding.

(II) Pond drain. All ponds shall have emergency drawdown piping to allow complete draining for maintenance. These should be incorporated into the previously described structures. Sufficient pumps and appurtenances shall be made available to facilitate draining of individual ponds if ponds cannot be drained by gravity.

(III) Emergency overflow. To prevent overtopping of dikes, emergency overflow should be provided.

B. Hydraulic Capacity. The hydraulic capacity for constant discharge structures and piping shall allow for a minimum of two hundred fifty percent (250%) of the design flow of the system. The hydraulic capacity for controlled discharge systems shall permit transfer of water at a minimum rate of six inches (6") (15.2 cm) of pond water depth per day at the available head.

(7) Submerged Sand Filters.

(A) Applications. Submerged sand filters may be used for solids and BOD_5 removal following waste stabilization ponds and are considered to be both a third lagoon cell and solids removal facility when designed according to the parameters in subsection (7)(B) of this rule.

(B) Design Details.

1. Following nonaerated waste stabilization ponds, the loading shall not exceed five (5) gallons per day per square foot (.2m^3/m^2/day) of sand. Following aerated waste stabilization ponds, the loading shall not exceed fifteen (15) gallons per day per square foot (.6m^3/m^2/day) of sand.

2. Clean graded gravel, preferably placed in at least three (3) layers should be placed around the underdrains and to a depth of at least six inches (6") (15 cm) over the top of the underdrains. Suggested gradings for the three (3) layers are: one and one-half inches to three-fourths inch (1 1/2"-3/4") (3.8 cm–1.9 cm), three-fourths inch to one-fourth inch (3/4"-1/4") (1.9 cm—.6 cm) and one-fourth inch to one-eighth inch (1/4"-1/8")(.6 cm-.3 cm).

3. At least twenty-four inches (24") (0.6m) of clean washed sand should be provided. The sand should have an effective size of 0.3—1.0 mm and a uniformity coefficient of 3.5 or less.

4. Open-joint or perforated pipe underdrains may be used. They should be spaced not to exceed ten-foot (10') (3.0m) center-to-center.

5. The earth base of the filters should be sloped to the underdrains or the underdrains may simply be placed in the gravel base on the flat bottom of the basin.

6. The depth of liquid above the sand must be adjustable from one to five feet (1-5') (.3m-1.5m).

7. At least two (2) cells must be provided with the combined capacity equal to that necessary for the design loading.

8. A vehicle access ramp from the top of the embankment down to the sand surface and running along one (1) side of the filter is a desirable feature for periodic maintenance of the filter.

(8) Miscellaneous.

(A) Fencing. The pond area shall be enclosed with an adequate fence to discourage trespassing and prevent entering of livestock. Minimum fence height shall be five feet (5') (1.5m). The fence may be of the chain link or woven type. Fencing shall not obstruct vehicle traffic or mowing operations on the dike. A vehicle access gate of sufficient width to accommodate mowing equipment shall be provided. All access gates shall be provided with locks.

(B) Access. An all-weather access road shall be provided to the pond site to allow year-round maintenance of the facility.

(C) Warning Signs. Appropriate permanent signs shall be provided along the fence around the pond to designate the nature of the facility and advise against trespassing. At least one (1) sign shall be provided on each side of the site and one (1) for every five hundred feet (500') (150m) of its perimeter.

(D) Flow Measurement. Refer to 10 CSR 20-8.140(8)(G).

(E) Groundwater Monitoring. An approved system of groundwater monitoring wells or lysimeters may be required around the perimeter of the pond site to facilitate groundwater monitoring. The use of wells and/or lysimeters will be determined on a case-by-case basis.

(F) Laboratory Equipment. Refer to 10 CSR 20-8.140(8)(D).

(G) Pond Level Gauges. Pond level gauges shall be provided.

(H) Service Building. Consideration in design should be given to a service building for laboratory and maintenance equipment.

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.210 Supplemental Treatment Processes

*PURPOSE: The following criteria have been prepared as a guide for the design of supplemental treatment processes. This rule is to be used with rules 10 CSR 20-8.110–10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers **Recommended Standards for Sewage Works** and are based* *on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons per day ($85.4m^3$) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(3) Phosphorus Removal by Chemical Treatment.

(A) General.

1. Method. Addition of line or the salts of aluminum or iron may be used for the chemical removal of soluble phosphorus. The phosphorus reacts with the calcium, aluminum or iron ions to form insoluble compounds. These insoluble compounds may be coagulated with or without the addition of a coagulant aid such as polyelectrolyte to facilitate separation by sedimentation.

2. Design basis. Laboratory, pilot or full scale trial of various chemical feed systems and treatment processes are recommended to determine the performance level achievable, cost-effective design criteria and ranges of chemical dosages required. Systems shall be designed with sufficient flexibility to allow for several operational adjustments in chemical feed point location, chemical feed rates and for feeding alternate chemical compounds.

(B) Process Requirements.

1. Dosage. The chemical dosage required shall include the amount needed to react with the phosphorous in the wastewater, the amount required to drive the chemical reaction to the desired state of completion and the amount required due to inefficiencies in mixing or dispersion. Excessive chemical dosage should be avoided.

2. Chemical selection. The choice of lime or the salts of aluminum or iron should be based on the wastewater characteristics and the economics of the total system. When lime is used it may be necessary to neutralize the high pH prior to subsequent treatment in secondary biological systems or prior to discharge in those flow schemes where lime treatment is the final step in the treatment process.

3. Chemical feed points. Selection of chemical feed points shall include consideration of the type of chemicals used in the process, necessary reaction times between chemical and polyelectrolyte additions, and the type of wastewater treatment processes and components utilized. Considerable flexibility in feed point location should be provided, and multiple feed points are recommended.

4. Flash mixing. Each chemical must be mixed rapidly and uniformly with the flow stream. Where separate mixing basins are provided, they should be equipped with mechanical mixing devices. The detention period should be at least thirty (30) seconds.

5. Flocculation. The particle size of the precipitate formed by chemical treatment may be very small. Consideration should be given in the process design to the addition of synthetic polyelectrolytes to aid settling. The flocculation equipment should be adjustable in order to obtain optimum flow growth, control deposition of solids and prevent floc destruction.

6. Liquid—solids separation. The velocity through pipes or conduits from flocculation basins to settling basins should not exceed 1.5 feet per second (0.46m/s) in order to minimize floc destruction. Entrance works to settling basins should also be designed to minimize floc shear. Settling basin design shall be in accordance with criteria outlined in 10 CSR 20-8.160. For the design of a sludge handling system, special consideration should be given to the type and volume of sludge generated in the phosphorus removal process.

7. Filtration. Effluent filtration shall be considered where effluent phosphorus concentrations of less than one (1) mg/l must be achieved.

(C) Feed Systems.

1. Location. All liquid chemical mixing and feed installations should be installed in corrosion-resistant pedestals and elevated above the highest liquid level anticipated during emergency conditions. Lime feed equipment should be located so as to minimize the length of slurry conduits. All slurry conduits shall be accessible for cleaning.

2. Liquid chemical feed system. Liquid chemical feed pumps should be of the positive displacement type with variable feed rate control. Pumps shall be selected to feed the full range of chemical quantities required for the phosphorus mass loading conditions anticipated with the largest unit out-of-service. Screens and valves shall be provided on the chemical feed pump suction lines. An air break or antisiphon device shall be provided where the chemical solution discharges to the transport water stream to prevent an induction effect resulting in overfeed. Consideration shall be given to providing pacing equipment to optimize chemical feed rates.

3. Dry chemical feed system. Each dry chemical feeder shall be equipped with a dissolver which is capable of providing a minimum five (5)-minute retention at the maximum feed rate. Polyelectrolyte feed installations should be equipped with two (2) solution vessels and transfer piping for solution makeup and daily operation. Makeup tanks shall be provided with an eductor funnel or other appropriate arrangement for wetting the polymer during the preparation of the stock feed solution. Adequate mixing should be provided by a large diameter, low-speed mixer.

(D) Storage Facilities.

1. Size. Storage facilities shall be sufficient to insure that an adequate supply of the chemical is available at all times. Exact size required will depend on size of shipment, length of delivery time and process requirements. Storage for a minimum of ten (10) days' supply should be provided.

2. Location. The liquid chemical storage tanks and tank fill connections shall be located within a containment structure having a capacity exceeding the total volume of all storage vessels. Valves on discharge lines shall be located adjacent to the storage tank and within the containment structure. Auxiliary facilities, including pumps and controls, within the containment area shall be located above the highest anticipated liquid level. Containment areas shall be sloped to a sump area and shall not contain floor drains. Bag storage should be located near the solution

makeup point to avoid unnecessary transportation and housekeeping problems.

3. Accessories. Platforms, ladders and railings should be provided as necessary to afford convenient, safe access to all filling connections, storage tank entries and measuring devices. Storage tanks shall have reasonable access provided to facilitate cleaning.

(E) Other Requirements.

1. Materials. All chemical feed equipment and storage facilities shall be constructed of materials resistant to chemical attack by all chemicals normally used for phosphorous treatment.

2. Temperature/humidity and dust control. Precautions shall be taken to prevent chemical storage tanks and feed lines from reaching temperatures likely to result in freezing or chemical crystallization at the concentrations employed. A heated enclosure or insulation may be required. Consideration should be given to temperature, humidity and dust control in all chemical feed room areas.

3. Cleaning. Consideration shall be given to the accessibility of piping. Piping should be installed with plugged wyes, tees or crosses at changes in direction to facilitate cleaning.

4. Drains and drawoff. Above-bottom drawoff from chemical storage or feed tanks shall be provided to avoid withdrawal of settled solids into the feed system. A bottom drain shall also be installed for periodic removal of accumulated settled solids.

(F) Hazardous Chemical Handling. The requirements of 10 CSR 20-8.140(9)(A) shall be met.

(G) Sludge Handling.

1. General. Consideration shall be given to the type and additional capacity of the sludge handling facilities needed when chemicals are used.

2. De-watering. Design of de-watering systems should be based, where possible, on an analysis of the characteristics of the sludge to be handled. Consideration should be given to the ease of operation, effect of recycle streams generated, production rate, moisture content, de-waterability, final disposal and operating costs.

(4) High Rate Effluent Filtration.

(A) General.

1. Applicability. Granular media filters may be used as a tertiary treatment device for the removal of residual suspended solids from secondary effluents. Where effluent suspended solids requirements are less than ten (10) mg/l, where secondary effluent quality can be expected to fluctuate significantly or where filters follow a treatment process where significant amounts of algae will be present, a pretreatment process such as chemical coagulation and sedimentation or other acceptable process should precede the filter units. Pretreatment units shall meet the applicable requirements of section (3) of this rule.

2. Design consideration. Care should be given in the selection of pumping equipment ahead of filter units to minimize shearing of floc particles. Consideration should be given in the plant design to providing flow equalization facilities to moderate filter influent quality and quantity.

(B) Filter Types. Filters may be of the gravity-type or pressure-type. Pressure filters shall be provided with ready and convenient access to the media for treatment or cleaning. Where greases or similar solids which result in filter plugging are expected, filters should be of the gravity-type.

(C) Filtration Rates.

1. Allowable rates. Filtration rates shall not exceed five (5) gallons per minute per square foot based on the maximum hydraulic flow rate applied to the filter units.

2. Number of units. Total filter area shall be provided in two (2) or more units, and the filtration rate shall be calculated on the total available filter area with one (1) unit out-of-service.

(D) Backwash.

1. Backwash rate. The backwash rate shall be adequate to fluidize and expand each media layer a minimum of twenty percent (20%) based on the media selected. The backwash system shall be capable of providing a variable backwash rate having a maximum of at least twenty (20) gpm/sq. ft. (13.6 $l/m^2/s$) and a minimum backwash period of ten (10) minutes.

2. Backwash. Pumps for backwashing filter units shall be sized and interconnected to provide the required rate to any filter with the largest pump out-of-service. Filtered water should be used as the source of backwash water. Waste filter backwash water shall be adequately treated.

(E) Filter Media.

1. Selection. Selection of proper media size will depend on the filtration rate selected, the type of treatment provided prior to filtration, filter configuration and effluent quality objectives. In dual or multi-media filters, media size selection must consider compatibility among media.

2. Media specifications. The following table provides a listing of the normal acceptable range of media sizes and minimum media depths. The designer has the responsibility for selection of media to meet specific conditions and treatment requirements relative to the project under consideration.

Media Sizes, mm and Minimum Depths, (in)

	Single Media	Dual Media	Multi Media
Anthracite	—	1.0–2.0 (20")	1.0–2.0 (20")
Sand	1.0–4.0 (48")	0.5–1.0 (12")	0.6–0.8 (10")
Garnet or Similar Material	—	—	0.3–0.6 (2")

Uniformity Coefficient shall be 1.7 or less.

(F) Filter Appurtenances. The filters shall be equipped with washwater troughs, surface wash or air scouring equipment, means of measurement and positive control of the backwash rate, equipment for measuring filter head loss, positive means of shutting off flow to a filter being backwashed and filter influent and effluent sampling points. If automatic controls are provided, there shall be a manual override for operating equipment, including each individual valve essential to the filter operation. The underdrain system shall be designed for uniform distribution of backwash water (and air, if provided) without danger of clogging from solids in the backwash water. Provision shall be made to allow periodic chlorination of the filter influent or backwash water to control slime growths.

(G) Reliability. Each filter unit shall be designed and installed so that there is ready and convenient access to all components and the media surface for inspection and maintenance without taking other units out-of-service. The need for housing of filter units shall depend on expected extreme climatic conditions at the treatment plant site. As minimum, all controls shall be enclosed. The structure housing filter controls and equipment shall be provided with adequate heating and ventilation equipment to minimize problems with excess humidity.

(H) Backwash Surge Control. The rate of return of waste filter backwash water to treatment units shall be controlled so that the rate does not exceed fifteen percent (15%) of the design average daily flow rate to the treatment units. The hydraulic and organic load from waste backwash water shall be considered in the overall design of the treatment plant. Surge tanks shall have a minimum capacity of two (2) backwash volumes, although additional capacity should be considered to allow for operational flexibility. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest unit out-of-service.

(I) Backwash Water Storage. Total backwash water storage capacity provided in an effluent clearwell or other unit shall equal or exceed the volume required for two (2) complete backwash cycles.

(J) Proprietary Equipment. Where proprietary filtration equipment not conforming to the preceding requirements is proposed, data which supports the capability of the equipment to meet effluent requirements under design conditions shall be provided. The equipment will be reviewed on a case-by-case basis at the discretion of the agency.

(5) Microscreening.

(A) General.

1. Applicability. Microscreening units may be used following a biological treatment process for the removal of residual suspended solids. Selection of this unit process should consider final effluent requirements, the preceding biological treatment process and anticipated consistency of biological process to provide a high quality effluent.

2. Design considerations. Pilot plant testing on existing secondary effluent is encouraged. Where pilot studies so indicate, where microscreens follow trickling filters or lagoons, or where effluent suspended solids requirements are less than ten (10) mg/l, a pretreatment process such as chemical coagulation and sedimentation shall be provided. Care should be taken in the selection of pumping equipment ahead of microscreens to minimize shearing of floc particles. The process design shall include flow equalization facilities to moderate microscreen influent quality and quantity.

(B) Screen Material. The microfabric shall be a material demonstrated to be durable through long-term performance data. The aperture size must be selected considering required removal efficiencies, normally ranging from twenty to thirty-five (20–35) microns. The use of pilot plant testing for aperture size selection is recommended.

(C) Screening Rate. The screening rate shall be selected to be compatible with available pilot plant test results and selected screen aperture size, but shall not exceed five (5) gallons per minute per square foot (3.40 $l/m^2/s$) of effective screen area based on the maximum hydraulic flow rate applied to the units. The effective screen area shall be considered the submerged screen surface area less the area of screen blocked by structural supports and fasteners. The screening rate shall be that applied to the units with one (1) unit out-of-service.

(D) Backwash. All waste backwash water generated by the microscreening operation shall be recycled for treatment. The backwash volume and pressure shall be adequate to assure maintenance of fabric cleanliness and flow capacity. Equipment for backwash of at least eight (8) gallons per minute per linear foot (1.66 l/m/s) of screen length and sixty (60) pounds per square inch (4.22 kgf/cm^2), respectively, shall be provided. Backwash water shall be supplied continuously by multiple pumps, including one (1) standby and should be obtained from microscreened effluent. The rate of return of waste backwash water to treatment units shall be controlled so that the rate does not exceed fifteen percent (15%) of the design average daily flow rate to the treatment plant. The hydraulic and organic load from waste backwash water shall be considered in the overall design of the treatment plant. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest unit out-of-service. Provisions should be made for measuring backwash flow.

(E) Appurtenances. Each microscreen unit shall be provided with automatic drum speed controls with provisions for manual override, a bypass weir with an alarm for use when the screen becomes blinded to prevent excessive head development and means for de-watering the unit for inspection and maintenance. Bypassed flows must be segregated from water used for backwashing. Equipment for control of biological slime growths shall be provided. The use of chlorine should be restricted to those installations where the screen material is not subject to damage by the chlorine.

(F) Reliability. A minimum of two (2) microscreen units shall be provided, each unit being capable of independent operation. A supply of critical spare parts shall be provided and maintained. All units and controls shall be enclosed in a heated and ventilated structure with adequate working space to provide for ease of maintenance.

AUTHORITY: section 644.026, RSMo 1986. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.220 Land Treatment

PURPOSE: The following criteria have been prepared as a guide for the design of land treatment systems. This rule is to be used with rules 10 CSR 20-8.110–10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers ***Recommended Standards for Sewage Works*** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions.

(A) Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(B) Land treatment is the application of wastewater at rates up to the maximum amount which can be renovated by the soil—plant filter without detrimental effects to surface or groundwater soils or crops.

(C) Wastewater reuse is the application of wastewater for maximum economic return from the cropping system. Application rates will approximate the irrigation deficit and normally will not exceed twelve inches (12") (30 cm) per year.

(2) Exceptions.

(A) This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons per day ($85.4m^3$) or less (see 10 CSR 20-8.020 for the requirements for those facilities).

(B) This rule shall not apply to land application systems designed for wastewater reuse. Due to the low application rates, little need for regulation exists at this time.

(3) Preliminary Considerations. Land treatment is the application of wastewater at rates not to exceed the maximum which can be renovated by the soil and vegetation without detrimental effects to surface or groundwater, soils or crops. Land treatment installations are to be used where the waste contains pollutants which can be successfully renovated through organic decomposition and the adsorptive, physical and chemical reactions in the soil and vegetation. The land treatment of wastewater may recharge the local groundwater or reemerge into streams; therefore, the quality, direction and rate of movement and local use of the groundwater, present and future, are important considerations in evaluating a proposed site. It is essential to maintain an aerated zone in the soil to provide good vegetative growth and removal of nutrients. A groundwater mound may develop after the system is in use. Major factors in the design of land treatment systems are topography, soils, geology, hydrology, weather, agricultural practice, crop, use of crop, adjacent land use, equipment selection and installation.

(4) Design Report. The design report shall include maps and diagrams as noted in the following. It shall also include any additional material that is pertinent about the location, geology, topography, hydrology, soils, areas for future expansion and adjacent land use.

(A) Location.

1. A copy of the USGS topographic map of the area (seven and one-half (7 1/2)-minute series where published), similar map or aerial photograph showing the exact boundaries of the spray field.

2. A topographic map of the total area under consideration by the applicant at a scale of approximately one inch to fifty feet (1":50') (2.54:15.2cm) with appropriate contour interval. It should show all buildings, the waste disposal system, the spray field boundaries and buffer zone. An additional map should show the spray field topography in detail with a contour interval of two feet (2') (61 cm) and include buildings and land use on adjacent lands within one-fourth (1/4) mile of the project boundary.

3. Water supply wells which might be affected shall be located and identified as to uses—for example, potable, industrial, agricultural and class of ownership; for example, public, private, etc.

4. All abandoned wells, shafts, etc., where possible, should be located and identified. Pertinent information thereon shall be furnished.

(B) Geology.

1. Geologic formation's name and the rock types at the site.

2. Degree of weathering of the bedrock.

3. Character and thickness of the surficial deposits.

4. Local bedrock structure including the presence of faults, fractures and joints.

5. The presence of any solution openings and sinkholes in carbonate terrain.

6. The source of the information in (4)(B)1.—5. must be indicated.

(C) Hydrology.

1. The depth to seasonal and permanent highwater tables (perched and/or regional) must be given, including an indication of seasonal variations.

2. The direction of groundwater movement and the point(s) of discharge must be shown on one (1) of the attached maps.

3. Chemical analyses indicating the quality of groundwater at the site must be included.

4. Indicate the source of the data in (4)(C)1.-3.

5. The following information shall be provided from existing wells and from the test wells as may be necessary:

A. Construction details—where available. Depth, well log, pump capacity, static levels, pumping water levels, casing, grout material and the other information as may be pertinent; and

B. Groundwater quality. For example, nitrates, total nitrogen, chlorides, sulfates, pH, alkalinities, total hardness, coliform bacteria and metal ions.

6. A minimum of one (1) groundwater monitoring well, where deemed necessary by the DGLS, must be drilled in each dominant direction of groundwater movement and between the project site and public well(s) and/or high capacity private wells with provision for sampling at the surface of the water table and at five feet (5') (1.5m) below the water table at each monitoring site. The location and construction of the monitoring well(s) must be approved by the agency. These may include one (1) or more of the test wells where appropriate.

(D) Evaluation of Effluent to be Applied. Representative samples are essential to properly evaluate the effluent. Where the discharge is from a sewage treatment plant, twenty-four (24)-hour samples proportioned to the rate of flow will be needed to obtain a representative sample. In cases where the effluent is stored for several days or longer, a single sample of the effluent will suffice. Analyses which will be of major importance will be for total suspended solid (TTS), a volatile suspended solid (VSS), sodium, calcium, magnesium, electrical conductivity (EC), nitrogen, phosphorous, metal ions and fluoride. The sodium absorption ratio (SAR) should be calculated from sodium, calcium and magnesium determination.

(E) Soils. All soils investigation should be performed by a qualified soil scientist.

1. A soils map should be furnished of the spray field, indicating the various soil types. This may be included on the large-scale topographic map. Soils information can normally be secured through the USDA Soil Conservation Service.

2. The soils should be named and their texture described.

3. Slopes and agricultural practice on the spray field are closely related. Slopes on cultivated fields should be limited to four percent (4%) or less. Slopes on sodded fields should be limited to eight percent (8%) or less. Forested slopes should be limited to eight percent (8%) for year-round operation but some seasonal operation slopes up to fourteen percent (14%) may be acceptable.

4. The thickness of soils should be indicated. Indicate how determined.

5. Data should be furnished on the exchange capacity of the soils. In cases of industrial wastes particularly, this information must be related to special characteristics of the wastes.

6. Information must be furnished on the internal and surface drainage characteristics of the soil materials. Location and depths to impermeable or restricted horizons should be indicated.

7. Proposed application rates should take into consideration the drainage and permeability of the soils and the distance to the water table.

(F) Agricultural Practice.

1. The present and intended soil-crop management practices, including forestation, shall be stated.

2. Pertinent information shall be furnished on existing drainage systems.

3. When cultivated crops are anticipated, a cropping and harvesting program by a qualified agronomist shall be included.

(G) Adjacent Land Use.

1. Present and anticipated use of the adjoining lands must be indicated. This information can be provided on one (1) of the maps and may be supplemented with notes.

2. The plan shall show existing and proposed screens, barriers or buffer zones to prevent blowing spray from entering adjacent land areas.

3. If expansion of the facility is anticipated, the lands which are likely to be used for expanded spray fields must be shown on the map.

(5) System Design.

(A) Treatment Before Land Application. The treatment of wastewater prior to application shall be adequate to prevent nuisance conditions from occurring in the treatment facility, in the storage basins or on the application site. When spray application is to be used, the system must also minimize the aerosol spread of pathogen. A primary lagoon cell loaded at a rate not to exceed thirty-four pounds (34 lbs.) BOD_5/acre/day (38 kilograms BOD_5/hectare/day) will be considered adequate to avoid nuisance conditions. Detention time of sixty (60) days or greater will be considered adequate to achieve pathogen reduction to acceptable levels. Other treatment methods may be used to meet these requirements and will be reviewed on a case-by-case basis.

(B) Storage Requirements. Storage shall be provided for the maximum capacity required to accommodate wastewater flows in excess of quantities which can be irrigated during the wettest year in ten (10). Computations for storage shall consider possible increases in wastewater flow during wet weather. If discharge to surface waters is permitted during portions of the year, storage facilities should be adequate to store excess wastewater flow during the period when discharge is not permitted. National Weather Service records should be used to estimate the number of days that weather will prevent the application of wastewater to the land.

(C) Application Rates. Application rates shall be determined for each individual site based on topography, soils, geology, hydrology, weather, agricultural practice, adjacent land use and application method. A balance calculation for water and each significant parameter should be prepared to show that the system performance meets the requirements of 10 CSR 20-7.031 Water Quality Standards. The agency will consider comments from the Division of Geology and Land Survey, the Soil Conservation Service and University of Missouri-Extension Division in evaluating the proposed application rate.

(6) System Monitoring. An appropriate monitoring system shall be provided to determine the quality of water leaving the land treatment site and entering surface and/or ground water. Analysis of soil and plant tissue samples may be required to monitor the effect of the wastewater on the soil and crop.

(7) Fencing. The project area shall be enclosed with a suitable fence to preclude livestock and discourage trespassing. A vehicle access gate of sufficient width to accommodate mowing equipment should be provided. All access gates should be provided with locks.

(8) Warning Signs. Appropriate signs should be provided along the fence around the project boundaries to designate the nature of the facility and advise against trespassing.

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979.*

**Original authority 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.500 Secondary Containment for Agrichemical Facilities

PURPOSE: The following criteria have been prepared as a guide for the design, construction and operation of secondary and operational area containment structures at bulk agrichemical facilities. This rule is to be used with rules 10 CSR 20-8.110–10 CSR 20-8.220 for the planning and design of the complete storage and containment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission regarding adequacy of design, submission of plans, approval of plans and approval of completed storage and containment facility. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. A facility need only to comply with these rules when it comes within the definition of an agrichemical facility. Any new agrichemical facility shall be in compliance with all of these rules before the commencement of any operational activities or any storage or use of agrichemicals. Upon adoption of these rules, all existing agrichemical facilities shall be in compliance with them as follows: secondary and operational area containment for pesticides—five (5) years from the date the rule is adopted; and secondary and operational area containment for fertilizers—five (5) years from the date the rule is adopted. Any facility that has a discharge of agrichemicals or process generated wastewater which results in damage to the environment may be required to take immediate steps to implement the secondary and operational containment requirements contained in this rule. All agrichemical facilities shall be registered and issued a general operating permit from the department on forms furnished by the department. Registration shall be valid for the life of the permit, terminated by the department or voluntarily withdrawn by the applicant. These criteria are based on the best information presently available and are similar to secondary containment regulations that have been implemented in other states. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to the regulated community. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that your name can be added to the mailing list.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) General. A facility need only to comply with these rules when they come within the definition of an agrichemical facility. Any new agrichemical facility shall be in compliance with all of these rules before the commencement of any operational activities or any storage or use of agrichemicals. All existing agrichemical facilities shall be in compliance with these rules as follows: secondary and operational area containment for pesticides—five (5) years from the date the rule is adopted; and secondary and operational area containment for fertilizers—five (5) years from the date the rule is adopted. Any existing agrichemical facility that has a discharge of agrichemicals or process generated wastewater to the environment will be required to take immediate steps to implement the secondary and operational containment requirements contained in this rule. All agrichemical facilities shall apply for an operating permit on forms furnished by the