MINIMUM DESIGN CRITERIA
FOR
MISSISSIPPI PUBLIC WATER SYSTEMS

Mississippi State Department of Health
Bureau of Public Water Supply

November 2019 - Final

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Introduction

This document is a compilation of the minimum design criteria for public water systems in Mississippi. The purpose of these written standards is to serve as a guide to public water system officials, consulting engineers, Certified Waterworks Operators, and Bureau of Public Water Supply staff in designing new public water systems and in making modifications to existing public water systems.

It is recognized that every situation has not been addressed and that there may be situations where certain aspects of these criteria do not apply. These instances will be handled on a case by case basis. The limitations of these design criteria are not meant to limit the scope of engineering design. Conversely, the development of new methods and innovative engineering design is encouraged. However, any new developments must be demonstrated to be satisfactory before approval can be given. These cases will be considered on an individual basis.

The 1997 Mississippi Legislature passed legislation revising the Mississippi Safe Drinking Water Act. This new law went into effect on July 1, 1997. One of the key provisions of this new law is a requirement that the engineering plans and specifications for extensions or modifications to public water systems must be approved by the Mississippi State Department of Health prior to beginning construction. The purpose of this new requirement is to protect the public health of all Mississippians by ensuring that all extensions or modifications to public water systems are designed and constructed in accordance with this agency's minimum design criteria. Violations of this law are subject to administrative penalties not to exceed $25,000 per day of violation. Additional information concerning our policy regarding when MSDH approval is required can be found on page 1 of this manual.

Questions or comments concerning this document or recommendations for improvement should be provided to the following address:

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Definitions

MSDH/BPWS – Mississippi State Department of Health, Bureau of Public Water Supply

MSDH – Mississippi State Department of Health

Bureau of Public Water Supply – a Bureau of the Office of Environmental Health, Mississippi State Department of Health

Public Water Supply or System – as defined in the Mississippi Regulations Governing Public Water Systems, promulgated under the Mississippi Safe Drinking Water Act

Shall or Must – these are used to denote a mandatory requirement

Should – this is used to denote a recommended or desirable condition in most cases

AWWA – American Water Works Association

U.S. EPA – United States Environmental Protection Agency

ASME – American Society of Mechanical Engineers

OSHA – Occupational Safety and Health Administration, U.S. Department of Labor

NSF – National Sanitation Foundation

ASTM – American Society for Testing and Materials

gpm – gallons per minute

ID – inside diameter

OD – outside diameter

psi – pounds per square inch

Consecutive Supplies – any public water system that receives water from another public water system for distribution

SSPC – Steel Structures Painting Council

USDA – United States Department of Agriculture

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5. "Recommended Standards for Water Works", Great Lakes - Upper Mississippi River Board of State Public Health & Environmental Managers, 2012

6. "Regulations Governing Public Water Supplies", Alabama Department of Environmental Management, December 2014

7. "Regulations Governing Public Water Systems", Mississippi State Board of Health, 1997

8. "Rules Governing Public Water Supplies", Section 0600 through 2500 of the North Carolina Administrative Code, Title 15A, Subchapter 18C, Department of Human Resources, Chapter 10, Health Services: Environmental Health, Subchapter 10D, Water Supplies

9. "State of Illinois Rules and Regulations", Title 35: Environmental Protection, Subtitle F: Public Water Supplies, Chapter II: Environmental Protection Agency, Parts 651-654, Technical Policy Statement

10. "State of the Art of Small Water Treatment Systems", U.S. Environmental Protection Agency, Office of Water Supply, Washington, D.C. 20460, August, 1977

11. Unpublished data, Bureau of Public Water Supply, Mississippi State Department of Health

12. "Waterworks Operator Manual", Bureau of Public Water Supply, Mississippi State Department of Health

13. "Small Water Systems Serving the Public", Conference of State Sanitary Engineers, U.S. Environmental Protection Agency, July 1978

14. "National Secondary Drinking Water Regulations." 40 CFR 143.3. 1991

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Part I - Engineering Document Submission

A. Preconstruction Requirements

1. **Siting of Facilities (Preliminary)**

   Prior to the design or expansion of the source and treatment facilities of a public water system, the facility site plan should be submitted to the Bureau of Public Water Supply. Particular attention should be given to the location and protection from contamination of proposed new sources of water.

2. **Plans and specifications approval**

   a. Prior to beginning construction on a new public water system, or for extensions or modifications to an existing public water system, complete plans and specifications shall be approved in writing by the Bureau of Public Water Supply. It is strongly encouraged that approval be obtained prior to advertising due to the possibility that the proposed design might be required to make additional modifications in order to secure approval by MSDH. The following general policy should be used to determine if MSDH approval is required for water supply extensions or modifications:

      MSDH approval is required for:

      - Water main extensions along public roads and any main extensions designed to serve more than one connection.
      - Water treatment modifications that will change the chemical or biological quality of the drinking water provided to the customers.
      - Water line replacement projects, except size for size replacements. Size for size water line replacement projects are considered "maintenance projects" and do not require formal approval.

      If there are questions whether a water supply project must be approved, prior to employing a consulting engineer, system officials should submit a written description of the proposed project to this agency for review. Water Supply staff engineers will review the proposed project and determine if MSDH approval is required. If MSDH approval is required, a consulting engineer must then be employed to develop engineering plans and specifications that must be submitted to the agency for review and approval prior to beginning construction.

b. At least one physical full set of plans and specifications must be prepared, sealed and signed by a professional engineer licensed to practice in Mississippi in accordance with the requirements of the Mississippi State Board of Registration for Professional Engineers and Land Surveyors. Additionally, an electronic version of the submitted plans and specification must be submitted via CD or other means of electronic document storage.

c. The required Engineering Documents Transmittal Form must be signed by the submitting water system's Responsible Official or a letter from the water system stating they are aware of and agree to serve the proposed project.

d. Incomplete and/or illegible documents will delay the review and approval process.

e. Separately bound specifications shall be submitted for public water systems. Standard specifications for projects may be approved and kept on file.

f. If requested, the MSDH will maintain, on file, a public water system's MSDH approved standard set of specifications for public water systems. The public water system's consulting engineer may then reference these approved specifications when submitting engineering projects for review and approval.

g. Plans and specifications submitted for review must be in accordance with Appendix B, "Information Needed for Bureau of Public Water Supply Review and Approval of Engineering Plans and Specifications for Mississippi Public Water Supplies".

3. Hydraulic Calculations for projects

   a. Depending on the project, the submission of hydraulic calculations may be required by the Bureau during plans and specifications review. Submittals where hydraulic calculations are particularly required include:

      i. Elevated storage tanks where source and/or treatment facilities are not located on the same site. This is needed to prove that the tanks can fill in off peak times.

      ii. Subdivisions or developments in remote locations without a nearby source or storage facilities.

iii. Fill hydraulics for booster station collector tanks

b. If submitted hydraulic calculations indicate that the proposed development and or subdivision will have effect to areas of the distribution causing negative pressures, the submitted project may not be approved.

B. Post Construction Requirements

When final approval is required, a letter of certification shall be submitted from the consulting engineer to the Bureau of Public Water Supply stating that the project was constructed in substantial compliance with the approved plans and specifications. Records of satisfactory microbiological results from an approved laboratory must be included with the certification. One set of as-built plans should be included if significant changes were made in the construction of the project. The Bureau of Public Water Supply, Mississippi State Department of Health must be notified of the final inspection in sufficient time to insure that a MSDH representative can be present. It strongly recommended that final approval be obtained by the consultant at project conclusion. This is especial necessary if project was constructed under the direction of an engineer not retained by the supplying water system.

C. Electronic Submissions

Electronic submissions are required to be submitted either on CD or USB drive in addition to the submitted one full size copy Arch D, Landscape (36.00 x 24.00 inches) for regional engineer review. Half scale (12.00 x 18.00 inches) plans may be permitted provided sufficient detail is given for the ease of engineering review. Electronic submission with the initial physical paper copy shall be the standard method for plan review submission. Details for this process are outlined in Appendix B, "Information Needed for Bureau of Public Water Supply Review and Approval of Engineering Plans and Specifications for Mississippi Public Water Supplies". As of October 2016, current federal submission requirements and limitations by the Department prevent electronic submission by email.

1. Plans

   Plans submitted in electronic form should meet the following requirements:

   a. File Format: Portable Document Format (PDF)

   b. Paper Size: Arch D, Landscape (36.00 x 24.00 inches). This is a PDF attribute.

c. Vector graphics are preferred because they minimize file size and are infinitely scalable.

d. For non-vector (raster, bitmap) graphics, resolution should be 200 pixels per inch (ppi).

e. Drawings should be scaled correctly with respect to the paper size.

f. Plans in PDF form should include the signed stamp of the Professional Engineer in charge of the project.

2. Correspondence submitted in electronic form should meet the following requirements:

a. File Format: Portable Document Format (PDF)

b. Paper Size: US Letter, Portrait (8.50 x 11.00 inches). This is a PDF attribute.

c. Text is preferred because it minimizes file size.

d. For non-text documents (such as scans), resolution should be 300 pixels per inch (ppi).

e. Changes to plans in response to Bureau comments may require re-submittal of plans via CD or USB Drive.

Part II – Water Usage Requirements

A. The anticipated usage for a proposed system should be based on actual data from similar systems, taking into account agricultural and industrial usage, lot size, degree of urbanization, water loss and other factors influencing water usage.

B. The water system should be designed to supply all existing homes and lots in the certificated area, whether or not they have requested service. A reasonable growth factor should be included.

C. In the absence of actual data, water systems should be designed to supply the demands in Table 1.

D. Fire flows should be based upon the requirements of the lending agency or other appropriate authority, such as the Mississippi State Rating Bureau.

Table 1 - Water Demands

Type of User	Average Usage (gallons per day per connection)	Peak Usage (gallons per day per connection)	Peak Demand (gallons per minute per connection)
Rural Homes	200	400	1
Urban Homes	400	600	1
Subdivisions	400	600	1
Rural Apartments/Trailers	133	267	2/3
Urban Apartments/ Trailers	276	400	2/3
Recreational Vehicles	100	200	1/2
Unmetered	150% of rural or urban, whichever applies		
Chickens		0.1 per chicken	Depends on waste system
Cattle or Hogs		15 per head	
Schools	15-20 per student	30-40 per student	
Hospitals	300	350	

*For less than 100 connections or units, the design peak demand is given by the demand curve in Appendix E, "Minimum Flow Requirements for Small Water Systems Without Fire Protection".

For apartments and trailers, the design peak demand is 2/3 of the demand curve. For recreational vehicles, the peak demand is 50% of the demand curve. For unmetered connections, the design peak demand is 150% of the demand curve. For non-community water supplies refer to Appendix E.

Example Demand Calculation

A school with 900 students

The school has irrigation lines so it will be considered unmetered

Peak Demand (gpd)/400 gpcd = connections

Peak Demand = 40 gpd x 900 students = 36,000 gallons

36,000/400 = 90 connections

Since system is unmetered multiply connections by a factor of 1.5

therefore 90 x 1.5 = 135 connection

Therefore, this school would be equivalent to a water system with 135 connections.

Part III - Wells

A. Well Driller Requirements

All wells for public water supplies shall be constructed by a water well contractor licensed by the Mississippi Department of Environmental Quality.

B. Well Permits

All wells shall be permitted as required by the Department of Environmental Quality. A copy of the well permit will be required for approval by the Bureau of Water Supply, Mississippi State Department of Health.

C. Location

Well sites shall be approved by the Bureau of Water Supply, Mississippi State Department of Health. The following criteria shall be considered in determining an acceptable well site:

1. Susceptibility of flooding - the top of the well casing shall be at least 1 foot above the 100-year flood or the highest year flood, whichever is higher. Documentation should be supplied with the submittal verifying these requirements are met.
2. Distance from existing wells (depends on characteristics of the formation)
3. Accessibility
4. Sources of pollution - Minimum distance of 100 feet. This includes abandoned wells that are not properly decommissioned.
5. Potential for development of the surrounding area
6. Proximity of roads, railroads, power lines, underground pipelines, cathodic protection systems and other possible causes of damage
7. Degree of natural protection from surface water.
8. The ability to obtain water that is free of sand and which meets the current U.S. EPA primary drinking water standards.
9. For wells that are less than 500 feet deep, the minimum distance from any source of pollution should be 200 feet.

10. If it is anticipated that the proposed well will required additional treatment beyond standard disinfection, appropriate site considerations should be flexible to accommodate the possible treatment footprint needs necessary to comply with primacy SDWA standards and any secondary standard demands of the public.

D. Test Holes

Test holes are drilled primarily to locate the depth of the aquifers, determine their relative thickness and to take sand samples of the aquifers penetrated. All test holes which will be used subsequently as test wells should be a minimum of 8 inches in diameter. Upon completion of a successful test hole, the following information should be made available to all interested parties.

1. Sand samples of the aquifer taken at 10 foot intervals and for any change in formation.
2. Drillers log of the test hole.
3. Gamma ray log of the test hole.
4. Electric log.
5. Sieve analysis of the sand samples for each 10-foot interval of each aquifer penetrated.

It is highly recommended that the public water system maintain a legible copy of each of the items listed above for their records.

E. Test Wells

A test well is a small diameter, low capacity temporary well constructed in an attempt to determine or confirm the water quality of the target sand formation where the permanent well is expected to be constructed. Not all new well construction requires a test well. If other wells are in the immediate area and at the same approximate depth, then a decision by the Licensed Professional Engineer and the Owner could result in deleting the test well from the project. While it is at the discretion of the consulting engineering, it is recommended that each test well constructed in the same test hole should be considered a separate pay item. A test well shall not be removed from the test hole until authorized by the Licensed Professional Engineer.

1. If a test well is authorized, the chemical analysis of the water, sand interval screened and related pumping data shall be properly documented and included in the final submittal

package. If multiple test wells are pulled from the same test hole, the documentation of each shall make it easy to determine which chemical analysis goes with which sand interval screened.

2. **Test Well Design.**
   a. Upper casing should have a minimum inside diameter of 6 inches to allow for pump clearance.
   b. Screens should be of wire wrap design with a minimum outside diameter of 4 inches and a minimum length of 40 feet unless the thickness of the water bearing sands are inadequate for 40 feet of TEST WELL screen to be installed. Slot size should retain from 45% to 60% of the aquifer material.
   c. Non-lead packers should be installed above and below the aquifer to limit the influence of other aquifers pierced by the test hole.
   d. The test well should be properly developed and water samples should be free of drilling mud and sand. **NOTE:** Only non-organic drilling mud should be utilized in the construction of water wells.
   e. The well should be pumped at a minimum rate of 75 gpm or 20% of the final design capacity.
   f. Drawdown measurements shall be made at regular intervals during the first 24 hours of pumping and afterward until the static water level in the well has recovered.

3. Physical and chemical analyses shall be made of the samples taken after the pumping test and analyzed by a Mississippi State Department of Health approved laboratory to determine the water's suitability for public water supply use. A legible copy of these analyses should be forwarded to the Bureau of Water Supply for the official record. Construction of the permanent well shall not begin until the Licensed Professional Engineer has reviewed and approved the physical and chemical analysis of the water.

F. Observation Wells

1. Observation wells for permanent use shall be properly protected from sources of contaminants in the same manner (requiring casing to be cemented) as permanent wells for a public water supply.

2. The casing should extend at least 1 foot above the expected 100-year flood and be provided with an overlapping, lockable cover with a lock.

G. Abandoned Holes, Test Wells and Wells

1. All abandoned wells, test wells, temporary observation wells and holes to or through any aquifer shall be filled with cement grout introduced at the bottom and pumped to the ground surface in one continuous operation.

2. A licensed Professional Engineer may be employed to design an alternate abandonment technique. Any alternate technique must be approved by the Bureau of Water Supply prior to its application. Written certification of completion from the licensed well driller in charge of the abandonment procedure is required to submit the original Well Decommissioning Form to MDEQ with copies to the Licensed Professional Engineer (if applicable) and the MSDH/BPWS. If the well being abandoned has a PWS ID tag, the tag shall be removed and returned to the MSDH/BPWS. The PWS ID number on the tag, if applicable, shall be included on the Well Decommissioning Form.

3. It is strongly recommended that if a public water supply has existing wells no longer in service, they have the well properly abandoned in accordance with MDEQ guidelines. This can be performed during the construction of new well at a potentially reduced cost.

H. Design of Wells Should Meet the Requirements of the Latest Revision of AWWA A100

1. **Capacity**

   A well or well field shall be designed to operate to prevent excessive depletion of the aquifer and to provide standby capacity.

2. **Well Casings**

   a. Well casings shall be installed to prevent the vertical migration or entrance of adjacent ground or surface water. They should be so constructed and installed to prevent corrosion by aggressive water. They should be sufficiently sized and installed to allow installation, maintenance, or measurements of the pump, water levels, lap pipe and screen. Table 2 indicates recommended casing sizes for various yields, taking into account pump efficiency, head losses and adequate clearance for proper installation of 1760 rpm vertical turbine pumps. In some cases, the casing may need to be larger than indicated by the table to allow for pump settings in the lap pipe. The use of submersible pumps requires additional clearance to prevent excessive head losses in the annulus between the motor and the casing.

Table 2 - Recommended Well Casing and Screen Diameters

Proposed well yield, gpm	Nominal size of pump bowls, inches	Optimum size of well casing, inches	Maximum screen size for gravel packed wells
50-100	6	10 ID	6
100-700	8	12 ID	8
250-1500	10	16 OD	10
700-2400	12	18 OD	12
900-3000	14	20 OD	16
3000-4500	16	24 OD	20

b. An annular space on the outside of the casing of at least 2-1/2 inches shall be sealed with cement grout for the full length of the casing. The well casing shall be cemented in place by the Halliburton or other satisfactory method. The Halliburton method requires forcing cement grout in the annular space between the casing and the drill hole from the bottom of the well to the top, thus assuring exclusion of all the water above the water-bearing stratum from which the supply is taken. The grout should be neat cement weighing at least 14 lbs./gal (13 lbs./gal is acceptable if grout contains 8 % bentonite gel).

c. The top of the well shall be sealed to prevent the entrance of contaminants. Properly protected vacuum relief openings should be provided except in the cases where prevented by artesian head.

d. The casing should be provided with an access pipe which is at least 2 inches in diameter to allow for water level measurements. If this is also used as the casing vent, it must be screened and elbowed.

e. The same size casing shall extend from above the top of the foundation to the top of the water bearing stratum.

f. Steel casings shall meet the requirements of the latest revision of the applicable AWWA standard.

g. PVC casings may be allowed provided the justification for their use outweighs the risk of failure. PVC casings shall be designed to withstand the stresses of installation but shall be limited to the following depths unless appropriate justification is provided:

SDR*	**Depth, FT**
26	125
21	250
17	500

* Check manufacturers nominal internal diameters

h. The interior of a mild steel outer casing, the interior/exterior of the lap pipe, pump column and suction pipe in wells with corrosive water should be protected with an EPA or NSF approved coating to prevent corrosion or constructed of corrosion resistant material such as stainless steel. Special attention should be given to sealing the column pipe, coupling, threads and joints.

i. A water tight joint is required between well casing and pump head.
The pump head shall be connected to the outside casing by a water-tight threaded connection or by the outside casing being carried to a point not less than one inch above the concrete pump head foundation. Before setting the pump head casing, the contractor shall provide a vacuum seal between the foundation and pump head casing where a partial vacuum will be created. Where submersible pumps are used, a satisfactory water-tight mechanical seal shall be provided.

j. The pump head shall be mounted on a chamfered concrete foundation not smaller than 24 inches square at the top, extending not less than 18 inches into the solid ground and not less than 18 inches above the finished grade or the 100-year flood elevation.

3. **Well Screens**

   Screens should be designed and installed in such a way as to maximize well efficiency, consistent with constraints of aquifer retention. Refer to Table 2.

   a. Screen slot sizes should be designed based on the gradation of the adjacent gravel pack or aquifer material, as determined by sieve analysis.

   b. Total open area of the screen should be such that the maximum entrance velocity is limited to 0.1 feet per second.

   c. The screen shall be constructed of type 304 stainless steel, be rod-based and wire wrapped. Other materials when adequately justified will be considered on a case by case basis. Shutter screens are not acceptable.

   d. The gradation of the gravel pack material should be based on the gradation of the adjacent aquifer material, as determined by sieve analysis. The thickness of the annular gravel envelope should be between 3 inches and 8 inches to allow complete development of the well.

   e. The bottom of the screen should be fitted with a backwash valve if needed to permit washing of the screen and to prevent inflow of sand. This backwash valve should be brass or stainless steel to prevent corrosion.

4. **Lap pipe**

   The lap pipe should extend into the casing a distance sufficient to assure concentric alignment of the screen and casing. This must be at least 60 feet for straight wall wells. For gravel packed wells, the lap pipe must be 60 feet or at least as long as the screen for alignment and for storage of additional gravel pack. It is understood that special site circumstances could require deviation from lap pipe length requirements. Those necessary deviations should be reflected in the submitted plans and specifications. The space between the lap pipe and the casing should be filled with specially graded gravel according to sieve analysis to prevent sand pumpage. Any deviation from these minimum lap pipe lengths must be approved by this agency prior to construction and will be considered strictly on a case-by-case basis.

5. **Pumping equipment**

a. The pumping equipment should be designed to deliver the required flow and pressure at the maximum efficiency available.

b. Appurtenances on wells shall include:

   i. 3/4 inch sampling faucet installed between the pump discharge flange and chlorination - if it is installed upstream of the check valve, it should be a non-hose bib design and should not be installed on the blind flange of the discharge tee.

   ii. Provision for adequate shaft lubrication:

      I. Water lubrication - line shaft vertical turbine pumps should be of the water lubricated type, if practical, to prevent problems resulting from the introduction of oil into the system.

         a. The pre-lubricating water should be from an approved source of water, preferably the well itself. If a foot valve is used to hold the pump column full of water, a simple bypass around the check valve is sufficient.

         b. The pre-lubricating water should not be allowed to run continuously into the well. A normally open solenoid valve should be used so that an electrical failure will not prevent the flow of lubricating water.

      II. If oil lubricated, a non-petroleum based product meeting USDA H1 standards should be used.

   ii. Test tee.

   iii. Check and gate valve.

   iv. Freeze protection where needed.

   v. A master meter shall be provided for all public water supply wells. It shall be installed downstream of the check valve according to the manufacturers recommendations and be properly sized to accurately determine well capacity and amount of water pumped.

   vi. Lightning and phase failure protection for all three-phase equipment

   vii. Anti-reverse ratchet to prevent backspin and a time delay.

viii. An air release valve prior to the check valve.

ix. A screened and elbowed (double ell) casing vent. (For flowing wells a check valve should be installed on the vent.)

x. Casing access pipe of at least 2 inches in diameter and optional single piece non-plastic airline gauge for water level measurements.

c. The use of a submersible pump with a foot valve eliminates the need for item ii.

d. Corrosion resistant materials should be used for the pumping equipment if the corrosiveness of the water is expected to significantly reduce the life of mild steel components.

I. Well Construction

1. An electrical resistivity and spontaneous potential log should be completed on each drilled TEST HOLE and be evaluated in relation to other data prior to installation of the casing.
2. The well should be developed to its maximum practical efficiency and be free of visible sand and drilling mud. Turbidity due to the drilling process and/or construction of the well should not exceed 5 NTUs.
3. A pumping test of sufficient duration should be completed with the temporary pumping equipment on the final well to determine anticipated capacity and drawdown.
4. The permanent pump bowls should be set to maintain a 30-foot minimum submergence after pumping for 24 hours at open discharge.
5. After drawdown has stabilized on the well, the permanent pump should have step tests performed to determine capacity. The steps should be in increments no greater than 10 psi and should be from open discharge to shut-off head. Drawdown shall be measured after stabilization for each increment of pressure.
6. Well efficiency - should be minimum of 70% for wells utilizing at least 60% of formation.

7. Water samples from the Permanent Well shall be collected and submitted to the Mississippi State Department of Health or a state approved laboratory for chemical analysis. Chemical Analysis results shall be part of the final submittal package.

J. Disinfection

1. All water used in the drilling and construction process shall be obtained from sources of proven satisfactory quality and shall meet the primary standards of the Safe Drinking Water Act Regulations.
2. Gravel to be placed in a well should be disinfected with a solution of at least 50 mg/l free chlorine. A residual of no less than 5 parts per million of chlorine shall be maintained in any water used for development.
3. Upon completion of the well, the well and adjacent aquifer shall be disinfected as necessary using a solution of 50 mg/l free chlorine applied for 24 hours.
4. After disinfection, the well shall be pumped until two consecutive chlorine-free samples are collected from the well which show no coliform bacteria and no confluent growth. The samples shall be collected, submitted and analyzed according to the Mississippi State Department of Health requirements. The second sample shall be collected following at least two hours of continuous pumping after the first sample. A disinfectant must not be applied between samples. The person collecting the official microbiological sample(s) must be a representative of the Mississippi State Department of Health, the Licensed Professional Engineer for the project, or the Certified Waterworks Operator for the public water supply. If so needed, system may request an operator from another system to pull necessary sample(s)
5. If water from a private well is used, microbiological samples shall be examined prior to use. Routine samples from public supplies may be used as a basis for determining if a supply is satisfactory.
6. The disinfection procedure should meet the current AWWA standard (C654). A solution strength of 50 mg/l free chlorine applied for 24 hours is recommended.
7. When a well has been repaired, such as lowering or replacing the pump, the well should be disinfected. At least two (2) microbiological water samples, taken 2 hours apart with

the well pumping continuously, must be obtained prior to placing the well back in service. No coliform bacteria should be present in these samples. If coliform is present, the well should be re-disinfected and re-sampled. If repeated well clearings and sampling still indicate the presence of coliform bacteria, then the well may be put back into service if adequate chlorination is provided.

8. Should the two (2) consecutive microbiological well clearing samples indicate E. Coli is present, the system has the following options:
    1. Discontinue the use of the well until repeated well clearings and sampling reveal well to be free of E.Coli. Once verified the well may resume regular service
    2. Provide 4-Log inactivation of viruses as a part of the system’s treatment process for the affected well. 4-Log calculations will be provided by the Bureau of Public Water Supply after necessary system operational information is collected.

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Part IV – Water Treatment

Treatment facilities shall be provided for all public water to the extent necessary to insure compliance with the Primary Drinking Water Standards established by the U.S. EPA. Treatment facilities should also be provided to the extent necessary to insure compliance with the Secondary Drinking Water Standards and to remove any other harmful or objectionable constituents or qualities. Refer to Appendix A and Appendix B.

A. Pilot Studies

Unless otherwise approved by the Director based on documentation provided by the design engineer, pilot studies are required for treatment processes other than chlorine disinfection or point of use installations. Pilot studies may be performed in the field using the proposed source water or in conjunction with bench scale testing in the lab using the proposed source water. The system shall obtain the Department's approval of a pilot study plan before the pilot study is implemented. A pilot study shall be conducted for a period that shall be determined by the design engineer and approved by MSDH. A final pilot study report with results shall be submitted to MSDH for review and approval.

1. Pilot Study Plan. A pilot study plan shall include the following and any other items required by MSDH on a case by case basis:

   a. Introduction and Background. The plan shall discuss general information about the project including the existing system, the reason for conducting the pilot study, and anticipated results of a successful pilot study.

   b. Alternative Processes. Provide a brief description of alternative processes that could be used if the proposed process is shown to be ineffective from the study.

   c. Procedures and Methods. The procedures and methods section shall discuss how the pilot study will be conducted, the time frame of the study, source water quality, how source water may be altered to mimic various source water quality conditions, and the water quality parameters that are monitored and evaluated to determine if the treatment process was effective. All procedures and methods shall meet all applicable AWWA requirements as per the latest addition of the applicable standard.

2. Pilot Study Report. The pilot study report shall include the following and any other items required by MSDH on a case by case basis:

   a. Introduction and Background. (see above)

   b. Results. A discussion of the overall pilot study progress, including any issues or problems and a general discussion of results of the study and what the results indicate. This discussion should determine parameters necessary for full scale implementation.)

   c. Conclusions. Conclusions and recommendation to proceed with the treatment process if the results of the study proved successful.

3. Additional project specific pilot study requirements approved by the Director shall be included in pilot study plans and reports.

4. Engineer's Seal Required. Pilot study plans and pilot study reports submitted to MSDH shall bear the imprint of a Mississippi licensed professional engineer's seal that is both signed and dated by the engineer.

B. Disinfection

Automatic chlorination equipment is required on all new public water supplies. Systems with one source/treatment facilities shall provide redundant chlorination to address regulatory compliance requirements. Chlorination is required on all previously un-chlorinated public water supplies at such time that improvements or extensions are made. Chlorination shall be required on those systems that have been unable to meet the microbiological standards of the Safe Drinking Water Act. Disinfectants other than chlorine may be approved on a case by case basis.

1. Gaseous chlorinators shall be of the type with the regulator mounted directly on the chlorine cylinder, which will eliminate any pressure tubing. Pressure systems may be allowed on a case by case basis at the discretion of the Director but never extending outside of the chlorine cylinder room.

2. Chlorine Feed Capacity. The design of each chlorinator shall permit:

a. the chlorinator capacity to be such that a free chlorine residual of at least 2 mg/l can be maintained in the system after 45 minutes of contact time during peak demand. Additionally, the equipment shall have the capacity to operate accurately over a feeding range of 0.2 mg/l to 4 mg/l and that achieves a minimum residual of 0.5 throughout the distribution system after the initial chlorine demand has been satisfied.

b. assurance that a detectable residual, either combined or free, can be maintained at all times, at all points within the intended area in the distribution system.

c. Switchover units or an approved alternative shall be installed on all surface water, GWUDIS or one source systems and are encouraged for all installations.

d. For compliance with the Ground Water Rule, systems with one well shall provide redundant disinfection feed. A switchover unit, by itself, will not be considered redundant disinfection feed unless the system is utilizing an additional injection and booster pump system.

3. Chlorine cylinders and chlorine pressure tubing should be isolated from electrical equipment, motors, pumps and other materials and chemicals subject to corrosion or oxidation.
4. Walk-in chlorinator and chlorine rooms shall have positive ventilation of at least one fresh air change per minute. Ventilation at the floor level should be provided for chlorinator and chlorine storage rooms.
5. Walk-in chlorine storage and chlorinator rooms shall not have locking restrictions when opening from the inside. The doors should swing open to the outside.
6. 100 and 150 lb. chlorine cylinders must be secured in an upright position.
7. Installation and controls for the chlorinator should be as indicated in Appendix H memo.
8. Chlorine contact time before the first customer should be considered. The calculation method should be in accordance with Minimum Design Criteria Supplement 1 CT Guidance for Surface Water Supplies and Supplement 2 CT Guidance for Ground Water Supplies.

9. Primary disinfection is the means to provide adequate levels of inactivation of pathogenic microorganisms within the treatment process. The effectiveness of chemical disinfectants is measured as a function of the concentration and time of contact, a "CT" value in units such as mg/L-min. The effectiveness of UV disinfection is determined through validation testing of each model and specific configuration of UV reactor proposed in the design.
10. Secondary disinfection is the means to provide an adequate disinfectant residual in the distribution system to maintain a chemical barrier and to control bacteriological quality of treated water.
11. For the safety of water system personnel, respiratory protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) should be available where chlorine gas is handled, and should be stored at a convenient heated location, but not inside any room where chlorine is used or stored. It is suggested that the units use compressed air, have at least a 30-minute capacity, and be compatible with or exactly the same as units used by the fire department responsible for the plant.
12. Provisions should be made to chemically neutralize chlorine gas where feed and/or storage is located near residential or developed areas in the event of any measured chlorine release. The equipment must be sized to treat the entire contents of the largest storage container on site. Additionally, depending on the amount chlorine gas present on site, an appropriate hazard mitigation plan may be required for the water system by the appropriate governing agency.
13. Alternative disinfection such as chloramines, Ozone, UV Light, and Hypochlorite should be designed as described in the applicable section in this document. For treatment plants including surface water, chemical design and storage should be as described in the Chlorine dioxide section if not included separately.
14. On-site hypochlorite generation systems shall be certified as meeting the NSF/ANSI Standard 61. Manufacturer recommendations for safety with respect to equipment electrical power and other considerations for the ANSI/NSF Standard 61 certified on-site chlorine generation system shall be followed.

C. Fluoridation

1. Fluoridation facilities shall be capable of maintaining a uniform fluoride concentration in the water between 0.6 mg/l and 1.2 mg/l with 0.7 mg/l being the optimized dose.
2. To facilitate precise control, fluoridation equipment shall not have excessive capacity over that required to maintain the target of the fluoride concentration required.
3. Automatic controls shall be provided which prevent excessive feed rates. The fluoridation unit shall be wired so that it can run only when the well or service pump runs. Manual fluoridation controls are not acceptable.
4. The fluoridation systems shall be designed to prevent back-siphonage or uncontrolled flow of fluoride into the water supply.

E. Corrosion Control and Stabilization

The primary premise behind the need for corrosion control is to minimize the possibility of the leaching of lead (Pb) and copper (Cu) into drinking water. While compliance with the Lead and Copper Rule (LCR) is a metric for determine corrosion control treatment's effectiveness, it will not be the sole metric for the determination as to whether treatment provides adequate corrosion control and stabilization. In addition to compliance with the LCR, PWS treatment systems, both existing and any proposed improvements, will be required to maintain adequate pH, alkalinity, and hardness levels to provide proper corrosion control. If a PWS will be or is utilizing phosphate addition for corrosion control, it will be monitored by the system as appropriate to its classification. Besides possible LCR exceedances, lack of proper corrosion control treatment can lead to increased operating expenses associated with the distribution system including flow rate reduction, potential premature replacement of water mains, and other customer plumbing issues as well as a loss of public health protection that customers expect. Systems both newly constructed or existing must have the appropriate corrosion control treatment in place based on a standard corrosivity determination methods. This is regardless of whether or not the system is currently exceeding the action levels set forth in the Lead and Copper Rule (LCR) based on sampling. If an existing water source(s) is determined to be providing corrosive water without proper treatment, then treatment will be required for that source serving the public water system. For new construction, if the source is anticipated to be corrosive in nature, then appropriate provisions for treatment must be considered as a part of the design.

1. Methods of corrosion determination of source water:
    a. Baylis Curve: Using raw water quality parameters, the curve will indicate whether source water is prone to scaling or corrosion of plumbing and distribution. If parameters of the source water on curve reflect no scaling or corrosion, treatment may not be required. If parameters of the source indicate that scaling or corrosion will be problem, then the appropriated level of treatment will be required for the system to stabilize or provide corrosion control.
    b. Langelier Saturation Index (LSI): Using raw water quality parameters, LSI calculation determines the tendency of water to scale or corrode plumbing and distribution piping. If the calculated index of the water is between -1.0 and +2.0 then the water is determined to be stable and treatment may not be necessary. If the calculated index deviates from the aforementioned range, corrosion control or stabilization treatment will be required by the public water supply.
    c. Coupon Study: a corrosion control coupon study could be performed to provide a quantitative estimate of the corrosion rates that currently are taking place or will take place. The coupon will also be a visual representation of the corrosion type that may be occurring within the distribution system.

2. Treatment Parameters

    a. Corrosion control plants should be capable of adjusting the pH to the CaCO3 stability point or to the appropriate pH required for a film forming additive such as phosphate.

    b. Sampling faucets prior to chemical addition must be provided on the degasifiers (aerators).

    c. Aerators should reduce the CO2 content of the water to 10 mg/l or less. Less efficient aerators may be required for situations where buildup is likely and will be approved on a case by case basis.

d. The maximum loading rate should be 10 gallons per minute per square foot for natural draft aerators and 20 gallons per minute per square foot for induced draft and force draft aerators.

e. All aerators without subsequent filtration shall be screened with corrosion resistant material and properly protected from insects and other contaminants.

f. All natural draft aerators should have an alternate chlorine application point prior to the aerator distribution tray to allow periodic treatment with chlorine to control algae growth.

g. Corrosion control plants should have a minimum detention time of 30 minutes to allow for an adequate chlorine contact time and for dissolution of chemicals.

h. Re-carbonation basins should have a minimum detention time of 20 minutes.

i. Phosphates may be used for corrosion control on a case by case basis provided that source water characteristics meet their minimum standards for use. If source water characteristics are lacking, then some primary corrosion control treatment may be necessary for the addition of phosphate chemicals to work properly.

j. If existing required corrosion control treatment for a PWS is found to inoperable or to have fallen into disrepair, the Bureau through various enforcement mechanisms will require appropriate repair and/or replacement.

E. Clarification

This is a combination of the processes of mixing, coagulation, flocculation and sedimentation to remove unwanted solids and to reduce the filter loading. These processes may be carried out in a single unit, the upflow clarifier. Tube settlers may be used to enhance sedimentation efficiency. The treatment scheme should be based on the chemistry of the water and the degree of treatment required, with the aid of jar tests, bench tests and pilot plants. Plants designed to treat surface water, groundwater under the direct influence of surface water, or for the removal of a primary drinking water contaminants shall have a minimum of two units each for coagulation, flocculation, sedimentation, and solids removal. It is intended that all design criteria be met with one complete train out of service. This is mandatory for plants treating surface water and groundwater under the direct influence of surface water.

1. Presedimentation

Waters containing high turbidity may require pretreatment, usually sedimentation, with or without the addition of coagulation chemicals.

a. Basin design: Presedimentation basins should have hopper bottoms or be equipped with continuous mechanical sludge removal apparatus, and provide arrangements for dewatering.

b. Inlet: Incoming water shall be dispersed across the full width of the line of travel as quickly as possible; short-circuiting must be prevented.

c. Bypass: Provisions for bypassing presedimentation basins shall be included.

d. Detention time: Three hours detention is the minimum period recommended; greater detention may be required.

2. Rapid Mix

The engineer shall submit the design basis for the velocity gradient (G value) selected, considering the chemicals to be added, water temperature, color, and other related water quality parameters.

a. Detention time: Instantaneous mixing preferred but not more than 30 seconds. For surface water using metal coagulants, uniform complete mixing for five seconds or less is recommended.

b. Minimum velocity gradient: 300 ft./sec./ft but equipment should be capable of imparting a velocity gradient of 750 ft/sec/ft. Actual design mixing should be established by appropriate testing based on water quality and expected chemical regime. Basins should be equipped with devices capable of providing adequate mixing for all treatment flow rates.

c. In-line mixers are acceptable as long as flow is fairly constant and complete mix is assured.

d. Location: the coagulation and flocculation basin shall be as close together as possible.

e. If flow is split, a means of modifying the flow to each train or unit should be provided.

3. Flocculation

a. The basin should be designed to prevent short circuiting and destruction of floc. Series compartments are recommended to further minimize short-circuiting and to provide tapered flocculation (i.e., diminishing velocity gradient). Individual basins must be designed to be isolated without disrupting plant operation. A drain and pumps or other automatic method should be provided to handle dewatering and sludge removal.

b. Detention time: 30-45 minutes with flow through velocity not less than 0.5 or greater than 1.5 feet per minute.

c. Mixing equipment should be driven by variable speed drives and external, non-submerged motors with the peripheral speed of paddles ranging from 0.5 to 3.0 feet per second.

d. Flocculation and sedimentation basins should be as close together as possible.

e. If flow is split, a means of measuring and modifying the flow to each train or unit should be provided.

4. Sedimentation

a. Conventional

i. Detention time: As determined by bench and pilot plant testing

ii. Velocity: 0.5 - 1.0 ft./min.

iii. Maximum overflow rate: 0.25 – 0.5 gpm/ft.2

iv. Outlet weir loading: 8 - 15 gpm/ft. The higher rates are for heavier floc such as that obtained from lime-soda softening.

v. Inlets should be designed for equal distribution of the water over the basin and for uniform velocities. Open ports, submerged ports, and similar entrance arrangements are required. A baffle should be constructed across the basin close to the inlet end and should project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin.

vi. Outlet weirs or submerged orifices should maintain velocities suitable for settling in the basin and prevent short-circuiting. The use of submerged orifices is recommended

vii. The entrance velocity through the submerged orifices should not exceed 0.5 feet per second.

viii. If flow is split, a means of modifying the flow to each train or unit should be provided.

ix. Sedimentation basins must be provided with a means for dewatering. Basin bottoms should slope toward the drain not less than one foot in twelve feet where mechanical sludge collection equipment is not required.

x. Flushing lines or hydrants shall be provided and must be equipped with backflow prevention devices.

xi. Sludge collection system shall be designed to ensure the collection of sludge from throughout the basin.

b. Conventional (Specific to Surface Water)

i. Length to width ratio should be 4 to 1 minimum or include baffling for necessary contact time.

ii. Length to depth ratio should be 15 to 1 minimum unless more efficient design can be proven by engineering analysis.

iii. Detention Time should range from 1.5 to 4 hours.

iv. Circular units will be handled case by case.

c. Tube settlers - Tube settlers may offer advantages over conventional sedimentation in many cases. Proposals for tube settlers should be supported by adequate data from pilot plant or full scale demonstrations.

d. Sludge handling and disposal - Adequate provisions should be made for automatic removal and approved disposal of water treatment plant sludge. Alternative methods of water treatment and chemical use should be considered as a means of reducing sludge handling and disposal problems.

5. Upflow Clarifiers

These are acceptable for clarification or softening where water characteristics and flow rates are uniform.

1. Upflow rate - The maximum upflow rates used vary from 0.75 gpm/ft^2 to 1.25 gpm/ft^2. The lower rates are for iron removal and surface water and the higher rates are for heavier floc such as for softening.
2. Maximum weir loading.
   i. Clarification: 10 gpm/ft.
   ii. Softening: 20 gpm/ft.
3. A method of reducing "sludge age" at end of clarifier should be included to prevent "resuspending" especially if treatment facility utilizes enhanced coagulation.

F. Filtration

Filter units may be either gravity filters or pressure filters, depending on the degree of pre-treatment required. Pressure filters are normally used to remove small amounts of iron and manganese, where clarification is not economical or practical. Gravity filtration shall be used on all surface water sources. Filtration shall be required on all new spring or surface water supplies. As every filter installation will vary from location and its intended application, circumstances may necessitate deviations from design criteria. Those deviations will be considered on a case-by-case basis.

1. A bypass should be constructed on all single unit filters to allow for maintenance. Multiple units with no bypasses shall be used for surface water treatment.
2. Where potassium permanganate is used prior to filtration, the chlorine application point should be as far as possible upstream of the permanganate application point.
3. The influent water should be baffled to prevent upset of the media.

4. The filter tank should be of sufficient height to allow the necessary media expansion required for adequate backwashing without loss of media. The expanded media should extend no closer than 12 inches from the bottom of the wash troughs during backwash.
5. Air wash facilities should be provided where manganese zeolite filter media is used.
6. Surface wash facilities are required to be used on gravity filters treating surface water. Air scour system may also be used provided adequate controls are in place to prevent loss of media within the filter during backwash cycles.
7. A sufficient quantity of water should be provided for a minimum backwash time of 20 minutes while still maintaining adequate flow to the system.
8. A means of measuring loss of head through the filter should be provided on each filter unit.
9. Filter to waste piping must be provided, along with provisions for automatically maintaining normal flow while filtering to waste.
10. A positive means of automatically controlling the backwash flow rate should be provided along with a means of measuring flow. The backwash rate should be designed to clean the media without excessive scour causing loss of media. A means of easy observation of the backwash water should be provided.
11. A means of sampling the influent and effluent of each filter unit shall be provided.
12. A means of monitoring filter effluent must be provided for each cell.
13. An automatic air release valve and a man hole which is at least 18 inches in the smallest dimension should be provided on pressure filters.
14. The filter media size, filter rate, backwash rate and media depth should be within the guidelines in Table 3. The higher filtration rates pertain to multimedia filters or anthracite filters with low solids loading. Dual media filters with 12 - 18 inches of anthracite are recommended.
15. In placing media in multimedia filters, each successive type of media shall be backwashed at least twice and skimmed to remove fine particles prior to placement of the next type of media.

16. The underdrains shall provide uniform backwash distribution over the entire area of the filter. They may be of the header and lateral type with graded gravel or they may be the false bottom type, with properly designed strainers in relation to the support and filter media proposed.

17. Settling ponds or other approved means should be considered for backwash water and other waste discharges in order to meet Mississippi Department of Environmental Quality (MDEQ) requirements. Necessary permitting from the MDEQ for any treatment system that will have waste residuals needing disposal or discharge is required prior to obtaining MSDH approval.

18. Provisions should be considered for the recycling backwash water according to SDWA Backwash Water Rule.

Table 3 - Filter Design Criteria

Parameter	**Media**		
	Sand	Anthracite	Mn Greensand
effective size, mm	0.45-0.55	0.7-1.2	
maximum uniformity coefficient	1.5	1.5	
filter rate, gpm/ft^2	2 - 4	2 - 4	2 - 4
backwash rate, gpm/ft^2	15 - 18	10 - 12	8 - 10
media depth, ft. * (excluding gravel)	2 - 3	2	1.5

* for single media filters

19. Filters for surface water or groundwater under the influence of surface water shall include on-line turbidimeters installed on the effluent line from each filter. All turbidimeters shall consistently determine and indicate the turbidity of the water in NTUs. Each turbidimeter shall report to a recorder that is designed and operated to allow the operator to accurately determine the turbidity at least once every 15 minutes. Turbidimeters on individual filters should be designed to accurately measure low-range turbidities and have an alarm that will sound when the effluent level exceeds 0.3 NTU. It is recommended that turbidimeters be placed in a location that also allows measurement of turbidity during filter to waste.

20. Particle monitoring equipment is recommended as a means to enhance overall treatment operations where used for surface water.

21. Support media

    i. Torpedo sand - A three-inch layer of torpedo sand shall be used as a supporting media for filter sand where supporting gravel is used, and shall have:
    1). effective size of 0.8 mm to 2.0 mm, and;
    2). uniformity coefficient not greater than 1.7.

    ii. Gravel - Gravel, when used as the supporting media shall consist of cleaned and washed, hard, durable, rounded silica particles and shall not include flat or elongated particles. The coarsest gravel shall be 2.5 inches in size when the gravel rests directly on a lateral system, and must extend above the top of the perforated laterals. Not less than four layers of gravel shall be provided in accordance with the following size and depth distribution:

Table 4 – Gravel Bed Design Criteria

Size	Depth
3/32 to 3/16 inches	2 to 3 inches
3/16 to ½ inches	2 to 3 inches
½ to ¾ inches	3 to 5 inches
¾ to 1½ inches	3 to 5 inches
1½ to 2½ inches	5 to 8 inches

Reduction of gravel depths and other size gradations may be considered upon engineering justification or when approved proprietary filter bottoms are specified.

22. Granular activated carbon (GAC) - Granular activated carbon as a single media may be considered for filtration only after pilot or full scale testing and with prior approval of the Director. The design shall include the following:

    a. The media must meet the basic specifications for filter media as given in this Section and the latest revision of AWWA B604-12.

    b. There must be provisions for a free chlorine residual and adequate contact time in the water following the filters and prior to distribution.

c. There must be means for periodic treatment of filter material for control of bacterial and other growth.
d. Provisions must be made for frequent replacement or reactivation. Reactivation must meet the latest revision of AWWA B604-13.

23. Biologically active filters - Biologically active filtration, as used herein, refers to the filtration of surface water (or a ground water with iron, manganese, ammonia or significant natural organic material) which includes the establishment and maintenance of biological activity within the filter media. Considerations for biologically active include:
    a. Objectives of biologically active filtration may include control of disinfection byproduct precursors, increased disinfectant stability, reduction of substrates for microbial re-growth, breakdown of small quantities of synthetic organic chemicals, reduction of ammonia-nitrogen, and oxidation of iron and manganese.
    b. Biological activity can have an adverse impact on turbidity, particle and microbial pathogen removal, disinfection practices; head loss development; filter run times and distribution system corrosion.
    c. Design and operation should ensure that aerobic conditions are maintained at all times.
    d. Biologically active filtration often includes the use of ozone as a pre-oxidant/disinfectant which breaks down natural organic materials into biodegradable organic matter and granular activated carbon filter media which may promote denser biofilms.
    e. Biologically active filters may be considered based on pilot studies pre-approved by the Director.
    f. The study objectives must be clearly defined and must ensure the microbial quality of the filtered water under all anticipated conditions of operation.
    g. The pilot study shall be of sufficient duration to ensure establishment of full biological activity; often greater than three months is required. Also, the pilot study shall establish empty bed contact time, biomass loading, and/or other parameters necessary for successful operation as required by the Director.
    h. The final filter design shall be based on the pilot plant studies and shall comply with all applicable portions of this section.

G. Membranes

Design flow rate (including flux determination) for a membrane system shall be determined by pilot study on the particular raw water with expected pretreatment after 30 days of continuous operation at 20 degrees Celsius. Temperature correction shall be made at 3rd party validation rate or 2.5 % per degree Celsius change from 20 degrees Celsius. If pilot study information is unavailable:

1. Pressure systems - Unless verified by challenge tests with exactly similar raw water – maximum design flux rate shall be:
   a. The flux rate at the lowest possible temperature encountered (usually 25 gfd or less), or
   b. The flux rate in similar (not exact) raw water conditions at 20 degrees Celsius after 30 days of continuous run time at manufacturers recommended flux.
2. Vacuum systems - Unless verified by challenge tests with exactly similar raw water – maximum design flux rate shall be:
   a. Flux rate at the lowest possible temperature encountered (usually 17 gfd or less), or
   b. Flux rate in similar (not exact) raw water conditions at 20 degrees Celsius after 30 days of continuous run time at manufacturers recommended flux.

   Note: flux rate declines with decreasing temperature and increased fouling. Determination of selection method must be approved by director in absence of pilot study results.
3. Ceramic Membranes – These membranes are much less susceptible to temperature variation than organic membranes and the maximum allowable flux rate is 10 to 15 times that of organic membranes. If the Director approves installation without pilot studies as stated above in sections 1 and 2, then the maximum approvable flux rate is:
   a. 175 gpf for systems seeking log credit for crypto (4 log), giardia (4 log), and virus (1 log) or 10 times the allowable rate for the comparable category of organic membrane.
   b. 375 gpf for groundwater systems not seeking log credit or 15 times the allowable rate for the comparable category of organic membrane.
   c. If choosing this membrane type, manufacturer shall declare pore size and flux rate or approval **shall not** be given.

4. The minimum recovery rates can be as low as 50% for highly challenged (fouling and cold) but generally average between a maximum of 85% and 95 % according to EPA guidance. Recovery rates for a membrane system shall be determined by pilot study on the particular raw water with expected pretreatment unless waved by the Director.

5. As temperature is the major factor determining flux rate along with fouling, system should be designed based on expected temperature ranges for the raw water to be treated. The following table gives an example of temperature effect on flux rate.

Table 5 – Temperature Correction for Membranes

Loss in flow associated with feed water temperatures below standard test conditions 25ºC (77ºF). This table assumes that trans-membrane pressure is held constant and only water temperature is changed.		
Temperature Degrees C	*Degrees F*	*Correction Factor*
25	77	1
22.5	72.5	0.93
20	68	0.86
17.5	63.5	0.80
15	59	0.74
12.5	54.5	0.69
10	50	0.64
7.5	45.5	0.60
5	41	0.55
2.5	36.5	0.51

6. Source water quality to be treated must be presented for review by the Bureau (see list of constituents to be evaluated below). Unless required/approved (in advance) by MSDH, the list will be those contained in the latest revision of AWWA B110-09.

Table 6 - Membrane Piloting Suggested Water Quality Sampling Schedule

	MF/UF			***NF/RO***		
Parameter$_1$	***Feed***	***Concentrate***	***Filtrate***	***Feed***	***Concentrate***	***Filtrate***
Algae	***W***		***W***	***W***		
Color	***W***	***M***	***W***	***W***	***M***	***W***
HPC	***M***		***M***	***M***		***M***
Particle counts		***C***			***C***	
pH	***D***	***W***	***W***	***C***	***W***	***W***
SDI				***W***		

Taste & odor	M	M	M	M	M	M
Temperature	C			C		
TOC	W	M	W	W	M	W
Total coliform	W		W	W		
TSS	M	M	M			
Turbidity	C	M	C	C		W
UV-254	W	M	W	W		W
Alkalinity	W	M	W	W	W	W
Barium				W	W	W
Hardness	W		W	W	W	W
Iron	W		W	W	W	W
Manganese	W		W	W	W	W
Silica				W	W	W
Sulfate	W		W	W	W	W
TDS	W		W	C	W	C
HAAs /HAA5s[2]			M			M
TTHMs[2]			M			M

1 General surface water parameters – site specific parameters may be needed i.e. groundwater

2 Must be simulated distribution

Key: Based on minimum 90 day pilot, decreased interval for shorter runs

C = Continuous; D = Daily; W = Weekly; M = Monthly

7. Required pretreatment with appurtenances designated (both included with system and external) which may include but are not limited to
    a. Bag or cartridge filters
    b. Direct coagulation
    c. Coagulation, flocculation, and sedimentation
    d. Conventional treatment
7. Recycled flows and treatment if any
8. Layout drawings showing all buildings, and appurtenances
9. Layout drawings showing controls and electrical system
10. Complete system description
11. Detailed dimensioned skid and layout drawings
12. Process flow diagram and flow balance
13. Process and instrumentation diagrams

14. Functional description of the system operation including backwash, CIP, CEB, and integrity test
15. Backwash - necessary cleaning method for trans-membrane pressure (TMP) reduction. Backwash may consist of several operations that may be used alone or in conjunction to reduce TMP. Flux enhancement techniques may vary in frequency, duration, and timing depending on process employed. Variations from MDC must be approved individually.
    a. Air scrub (Every 15 -30 mins.)
    b. Forward flush (Every 15 -30 mins.)
    c. Reverse flush (Every 15 -30 mins.)
16. Clean in Place (CIP) – all systems need a method to chemically clean the membrane for TMP to return to the original functional level.
    a. Consists of two phases: caustic clean and acid clean
    b. Typically performed once per month
17. Enhanced flux maintenance (EFM) including chemically enhanced backwash (CEB) – pilot study may reveal it to be necessary to apply a enhanced flux maintenance (EFM) or chemically enhanced backwash (CEB) to reduce fouling and maintain lower TMP.
    a. CEB is typically performed weekly, but sometimes as often as daily.
    b. During CEB, a solution of sodium hypochlorite is re-circulated through the module for up to 90 minutes.
    c. CEB is designed on case-by-case basis
18. Integrity Testing
    a. Direct**:** A physical test applied to a membrane unit in order to identify and isolate integrity breaches.
        i. Pressure-based tests (e.g., pressure decay, diffusion flow, etc.)
        ii. Marker-based tests
            1) Significance: Must be used to verify removal efficiency in routine operation

Table 7 – Performance Criteria for Direct Integrity Tests

Criterion	Definition	Value
Resolution	The smallest integrity breach that is detectable	3 microns
Sensitivity	The maximum LRV that is verifiable	Site-specific
Testing Frequency	How often a direct integrity test is conducted	once per day*

*an integrity test result (control limit) showing a loss of the verified log removal credit triggers a response which may include repair, CIP, or other cleaning response and/or a reporting requirements.

b. Indirect: A test primarily based on monitoring water quality as a surrogate of membrane integrity

   i. Turbidity monitoring

   ii. Particle count and particle monitoring - must be used for continuous integrity monitoring if direct method cannot monitor integrity continuously

      Continuous indirect integrity testing

      1) Continuous sampling interval < 15 min.

      2) Control limit for turbidity monitoring: < 0.15 NTU in a period of longer than 15 min.

      3) Incidents exceeding control limit trigger require direct integrity test

19. Valve schedule and operating position during each cycle of membrane operations

20. Clear delineation of block and bleed assembly or equivalent assembly equally or more protective against cross-connections

21. Operational protocol to assure backflow prevention during CIP (and CEB as necessary)

22. Filtrate sample locations to determine compliance and direct integrity testing.

23. Predicted filtrate, permeate, or product quality based on required source water quality and operating parameter.

H. Water with Low Iron and Manganese Concentrations

Water with low iron and manganese concentrations (0.3 - 1.5 mg/l Fe, 0.05 - .30 mg/l Mn) may not require clarification prior to filtration. A detention time of 30 minutes should be provided to allow for complete oxidation, unless potassium permanganate is used as an oxidant.

I. Chemicals

1. Chemical containers should be labeled to provide the following information:
   a. Chemical name, purity and concentration
   b. Name and address of supplier
   c. Expiration date where applicable
1. Chemicals should meet the latest revision of the applicable AWWA standards and have NSF approval for use in potable water.
2. Chemical additions to the water shall be compatible under recommended dosages and should not impair the efficiency of disinfection.
3. In general, no "plug in" controls on chemical feed or hand controls that allow chemical feed to occur without plant (well) running.

J. Ozone

1. Feed gas preparation (In general, must meet latest version of applicable AWWA Standard) Feed gas can be air, oxygen enriched air, or high purity oxygen. Sources of high purity oxygen include purchased liquid oxygen conforming with AWWA Standard B-304; on site generation using cryogenic air separation; or temperature, pressure or vacuum swing (adsorptive separation) technology. In all cases, the design engineer must ensure that the maximum dew point of -76°F (-60°C) will not be exceeded at any time
   a. Air feed
      i. Air compression
         I. Air compressors shall be of the liquid-ring or rotary lobe, oil-less, positive displacement type for smaller systems or dry rotary screw compressors for larger systems.
         II. The air compressors shall have the capacity to simultaneously provide for maximum ozone demand, provide the air flow required for purging the desiccant dryers (where required) and allow for standby capacity.
         III. Air feed for the compressor shall be drawn from a point protected from rain, condensation, mist, fog and contaminated air sources to minimize moisture and hydrocarbon content of the air supply

IV. A compressed air after-cooler, entrainment separator, or a combination of the two (2) with automatic drain shall be provided prior to the dryers to reduce the water vapor.

V. A back-up air compressor must be provided so that ozone generation is not interrupted in the event of a break-down.

ii. Air drying

I. Dry, dust-free and oil-free feed gas must be provided to the ozone generator. Dry gas is essential to prevent formation of nitric acid, to increase the efficiency of ozone generation and to prevent damage to the generator dielectrics. Sufficient drying to a maximum dew point of -76°F (-60°C) must be provided at the end of the drying cycle.

II. Drying for high pressure systems may be accomplished using heatless desiccant dryers only. For low pressure systems, a refrigeration air dryer in series with heat-reactivated desiccant dryers shall be used.

III. A refrigeration dryer capable of reducing inlet air temperature to 40°F (4°C) shall be provided for low pressure air preparation systems. The dryer can be of the compressed refrigerant type or chilled water type.

IV. For heat-reactivated desiccant dryers, the unit shall contain two (2) desiccant filled towers complete with pressure relief valves, two (2) four-way valves and a heater. In addition, external type dryers shall have a cooler unit and blowers. The size of the unit shall be such that the specified dew point will be achieved during a minimum adsorption cycle time of sixteen (16) hours while operating at the maximum expected moisture loading conditions.)

V. Multiple air dryers shall be provided so that the ozone generation is not interrupted in the event of dryer breakdown

VI. Each dryer shall be capable of venting "dry" gas to the atmosphere, prior to the ozone generator, to allow start-up when other dryers are "on-line."

iii. Air filters

I. Air filters shall be provided on the suction side of the air compressors, between the air compressors and the dryers and between the dryers and the ozone generators.

II. The filter before the desiccant dryers shall be of the coalescing type and be capable of removing aerosol and particulates larger than 0.3 microns in diameter. The filter after the desiccant dryer shall be of the particulate type and be capable of removing all particulates greater than 0.1 microns in diameter, or smaller if specified by the generator manufacturer.

iv. Piping in the air preparation system can be common grade steel, seamless copper, stainless steel or galvanized steel. The piping must be designed to withstand the maximum pressures in the air preparation system.

b. Liquid oxygen feed gas system

i. Liquid oxygen storage system

I. The bulk oxygen storage system and associated equipment must comply with the latest standards including the latest AWWA version and all applicable local, state, and federal codes.

II. The liquid oxygen storage system must include the liquid oxygen storage tank and all related safety devices, appurtenances and equipment required for operation.

III. The liquid oxygen storage tanks must be horizontal or vertical tanks with double wall construction. The inner shell of the tank must be designed, fabricated, tested, inspected and stamped in accordance with the applicable ASME Code requirements and supported within the outer shell. The outer shell must be designed in accordance with applicable standards for exterior pressure due to full internal vacuum and must be carbon steel.

IV. The liquid oxygen storage tank must be provided with a mounting base and anchor bolts. Mounting base and support framing for the storage tank must be welded to the tank.

V. The internal vessel pressure relief must consist of both automatic primary and secondary relief devices and manual tank vent valves. External vessel pressure relief must consist of an automatic relief device.

VI. The tank must be insulated in the annular ring with a high vacuum packing or composite insulation, such that the tank boil off rate must not exceed 0.25 percent of the tank capacity by weight per day.

VII. The tank must be equipped with an economizer system to direct the boiled-off gaseous oxygen to the ozone generation feed-gas system rather than venting to atmosphere.

VIII. The tank must be equipped with a pressure building system to maintain the minimum pressure and maximum flow required for the ozone generation system.

ii. Liquid oxygen vaporization system

I. At least two ambient air vaporizers must be provided for the liquid oxygen vaporization system including all related safety devices, appurtenances and equipment required for operation.

II. The vaporizers must operate in a duty and defrost cycle mode of operation. The vaporizer equipment must be designed to provide continuous vaporization of liquid oxygen for design gaseous oxygen flow rate conditions at the minimum design ambient air temperature.

III. The vaporizers must be single module ambient vaporizers, factory assembled unit complete with bracing, lifting lugs, pressure safety relief valves, necessary internal manifold(ing), flanged connections, and suitable for outside installation and operation. The materials of construction must be suitable for the design conditions and oxygen compatible.

IV. The vaporizers must be equipped with automatic vaporizer valve controls to provide automatic switchovers to standby vaporizers on a timed or temperature basis to prevent vaporizer freeze-up.

iii. Piping and appurtenances

I. All piping between liquid oxygen storage tanks and vaporizers must be seamless copper pipe or stainless steel. All gaseous oxygen (GOX) piping, valves and fittings between the vaporizers and the ozone generators must be stainless steel. All piping and valves must be suitable for cryogenic and oxygen gas service at the specified operating pressure. All liquid oxygen piping systems must be insulated in accordance with applicable standards.

II. Tank fill system must include a standard oxygen hose connector, check valve, pressure relief valve and drain valve. Fill system must be designed for appropriate connections.

III. A pressure regulating valve station must be installed downstream of the vaporizers to reduce gaseous oxygen pressure to the delivery pressure required for the ozone generation system. The valves must be certified for oxygen service.

IV. Gaseous oxygen cartridge-type particulate filter must be provided, complete with valves and appurtenances. The filter must be provided in the gaseous oxygen supply piping between the pressure regulating valve station and the ozone generators. The filter must retain particles as required by the manufacturer.

2. Ozone generator (In general, must meet latest version of applicable AWWA Standard)
   a. Capacity
      i. The production rating of the ozone generators shall be stated in pounds per day and kWhr per pound at a maximum cooling water temperature and maximum ozone concentration.
      ii. The design shall ensure that the minimum concentration of ozone in the generator exit gas will not be less than one (1) percent (by weight).
      iii. Generators shall be sized to have sufficient reserve capacity so that the system does not operate at peak capacity for extended periods of time resulting in premature breakdown of the dielectrics.)
      iv. The production rate of ozone generators will decrease as the temperature of the coolant increases. If there is to be a variation in the supply temperature of the coolant throughout the year, then pertinent data shall be used to determine production changes due to the temperature change of the supplied coolant. The design shall ensure that the generators can produce the required ozone at maximum coolant temperature.
      v. Appropriate ozone generator backup equipment must be provided.
   b. Electrical.

The generators can be low, medium or high frequency type. Specifications shall require that the transformers, electronic circuitry and other electrical hardware be proven, high quality components designed for ozone service.

c. Cooling.

Adequate cooling shall be provided. The cooling water must be properly treated to minimize corrosion, scaling and microbiological fouling of the water side of the tubes. Where cooling water is treated, cross connection control shall be provided to prevent contamination of the potable water supply.

d. Materials.

To prevent corrosion, the ozone generator shell and tubes shall be constructed of Type 316L stainless steel.

3. Ozone contactors: (In general, must meet latest version of applicable AWWA Standard)

a. Bubble diffusers.

i. Where disinfection is the primary application, a minimum of two (2) contact chambers, each equipped with baffles to prevent short circuiting and induce countercurrent flow, shall be provided. Ozone shall be applied using porous-tube or dome diffusers.

ii. The minimum contact time shall be ten (10) minutes. A shorter contact time (CT) may be approved by the Department if justified by appropriate design and “CT” considerations.

iii. Where taste and odor control is of concern, multiple application points and contactors shall be considered.

iv. Contactors shall be separate closed vessels that have no common walls with adjacent rooms. The contactor must be kept under negative pressure and sufficient ozone monitors shall be provided to protect worker safety.

v. Contact vessels can be made of reinforced concrete, stainless steel, fiberglass or other material which will be stable in the presence of residual ozone and ozone in the gas phase above the water level. If contact vessels are made of reinforced concrete, all reinforcement bars shall be covered with a minimum of one and one-half (1.5) inches of concrete.

vi. Where necessary, a system shall be provided between the contactor and the off-gas destruct unit to remove froth from the air and return the other to the contactor or other location acceptable to the reviewing authority. If foaming is expected to be excessive, then a potable water spray system shall be placed in the contactor head space.

vii. All openings into the contactor for pipe connections, hatchways, etc. shall be properly sealed using welds or ozone resistant gaskets such as Teflon or Hypalon.

viii. Multiple sampling ports shall be provided to enable sampling of each compartment's effluent water and to confirm “CT” calculations.

ix. A pressure/vacuum relief valve shall be provided in the contactor and piped to a location where there will be no damage to the destruction unit.

x. The depth of water in bubble diffuser contactors shall be a minimum of eighteen (18) feet. The contactor shall also have a minimum of three (3) feet of freeboard to allow for foaming.

xi. All contactors shall have provisions for cleaning, maintenance and drainage of the contactor. Each contactor compartment shall also be equipped with an access hatchway.

xii. Aeration diffusers shall be fully serviceable by either cleaning or replacement.

b. Other contactors, such as the venturi or aspirating turbine mixer contactor, may be approved by the Department provided adequate ozone transfer is achieved and the required contact times and residuals can be met and verified.

4. Ozone destruction units (In general, must meet latest version of applicable AWWA Standard)

a. A system for treating the final off-gas from each contactor must be provided in order to meet safety and air quality standards. Acceptable systems include thermal destruction and thermal/catalytic destruction units.

b. The maximum allowable ozone concentration in the discharge is 0.1 ppm (by volume).

c. At least two (2) units shall be provided which are each capable of handling the entire gas flow.

d. Exhaust blowers shall be provided in order to draw off-gas from the contactor into the destruct unit.

e. Catalysts must be protected from froth, moisture and other impurities which may harm the catalyst.

f. The catalyst and heating elements shall be located where they can easily be reached for maintenance.

5. Piping materials: (In general, must meet latest version of applicable AWWA Standard)

   Only low carbon 304L and 316L stainless steels shall be used for ozone service with 316L preferred.

6. Joints and connections: (In general, must meet latest version of applicable AWWA Standard)

   a. Connections on piping used for ozone service are to be welded where possible.

   b. Connections with meters, valves or other equipment are to be made with flanged joints with ozone resistant gaskets, such as Teflon or Hypalon. Screwed fittings shall not be used because of their tendency to leak.

   c. A positive closing plug or butterfly valve plus a leak-proof check valve shall be provided in the piping between the generator and the contactor to prevent moisture reaching the generator.

7. Instrumentation: (In general, must meet latest version of applicable AWWA Standard)

   a. Pressure gauges shall be provided at the discharge from the air compressor, at the inlet to the refrigeration dryers, at the inlet and outlet of the desiccant dryers, at the inlet to the ozone generators and contactors, and at the inlet to the ozone destruction unit.

   b. Each generator shall have a trip which shuts down the generator when the wattage exceeds a certain preset level.

c. Dew point monitors shall be provided for measuring the moisture of the feed gas from the desiccant dryers. Where there is potential for moisture entering the ozone generator from downstream of the unit or where moisture accumulation can occur in the generator during shutdown, post-generator dew point monitors shall be used.
d. Air flow meters shall be provided for measuring air flow from the desiccant dryers to each of the other ozone generators, air flow to each contactor, and purge air flow to the desiccant dryers.
e. Temperature gauges shall be provided for the inlet and outlet of the ozone cooling water and the inlet and outlet of the ozone generator feed gas and, if necessary, for the inlet and outlet of the ozone power supply cooling water.
f. Water flow meters shall be installed to monitor the flow of cooling water to the ozone generators and, if necessary, to the ozone power supply.
g. Ozone monitors shall be installed to measure zone concentration in both the feed-gas and off-gas from the contactor and in the off-gas from the destruct unit. For disinfection systems, monitors shall also be provided for monitoring ozone residuals in the water. The number and location of ozone residual monitors shall be such that the amount of time that the water is in contact with the ozone residual can be determined.
h. A minimum of one ambient ozone monitor shall be installed in the vicinity of the contactor and a minimum of one shall be installed in the vicinity of the generator. Ozone monitors shall also be installed in any areas where ozone gas may accumulate.

8. Safety requirements (In general, must meet latest version of applicable AWWA Standard)

a. The maximum allowable ozone concentration in the air to which workers may be exposed must not exceed one-tenth part per million (0.1 ppm) by volume.
b. Noise levels resulting from the operating equipment of the ozonation system shall be controlled to within acceptable limits by special room construction and equipment isolation.
c. Emergency exhaust fans must be provided in the rooms containing the ozone generators to remove ozone gas if leakage occurs.

d. A sign shall be posted indicating "No smoking, oxygen in use" at all entrances to the treatment plant. In addition, no flammable or combustible materials shall be stored within the oxygen generator areas.

K. Chlorine Dioxide

1. Chlorine dioxide generators: Chlorine dioxide may be used for regulatory compliance for meeting log inactivation requirements of the surface water treatment rules or the disinfection byproducts precursor removal requirements. Chlorine dioxide used solely for aesthetic treatment will not be required to include the redundancy components, disinfection efficacy, or disinfection byproduct reduction. In all cases, disinfection byproduct formation must be addressed.

a. At minimum, bench scale testing must be conducted to determine chlorine dioxide demand and decay kinetics for the specific water being treated in order to establish the correct design dose for required log inactivation compliance (if required), oxidation reactions, and chlorite generation.

b. If chlorine dioxide is being employed for the reduction of disinfection byproducts in response to a violation, actual or simulated distribution system testing must be performed to assess the impact of chlorine dioxide addition on disinfection byproduct formation.

c. Chlorine dioxide generation equipment must be factory assembled pre-engineered units. All materials, construction, and associated testing shall be in accordance with the latest revision of the appropriate AWWA Standard.

d. Minimum yield requirements: (as determined by the latest revision of AWWA Standard Method 4500-ClO_2)

i. Hydrochloric acid and sodium chlorite systems must have a minimum yield of 80% across the proposed feed range. Unit must have maximum production limit of 30 lb per day.

ii. Gaseous chlorine and sodium chlorite systems must have a minimum yield of 95% across the proposed feed range. The excess free chlorine must not exceed five percent of the theoretical stoichiometric concentration.

iii. Gaseous chlorine and solid sodium chlorite systems must have minimum yield of 95% across the proposed feed range.

iv. Hydrochloric acid, Sodium chlorite, Sodium hypochlorite system must have a minimum yield of 90% across the proposed feed range. The excess free chlorine must not exceed five percent of the theoretical stoichiometeric concentration. (Note: *minimum yields may change subject to latest AWWA/Ten States revisions or industry update available at time of design)*

2. Chlorine Dioxide Feed system.
   a. Use fiberglass reinforced vinyl ester plastic (FRP) or high density linear polyethylene (HDLPE) tanks with no insulation.
   b. If centrifugal pumps are used, provide Teflon packing material. Pump motors must be totally enclosed, fan-cooled, equipped with permanently sealed bearings, and equipped with double mechanical seals or other means to prevent leakage.
   c. Provide chlorinated PVC, vinyl ester or Teflon piping material. Do not use carbon steel or stainless steel piping systems.
   d. Provide glass view ports for the reactor if it is not made of transparent material.
   e. Provide flow monitoring on all chemical feed lines, dilution water lines, and chlorine dioxide solution lines.
   f. Provide a means to verify calibrated feed flow to each application feed point.
   g. Control air contact with chlorine dioxide solution to limit potential for explosive concentrations building up within the feed facility.
   h. All chlorite solutions shall have concentrations less than 30%. Higher strength solutions are susceptible to crystallization and stratification.
3. Storage requirements (these are specific for a treatment plant employing chlorine dioxide, however they can be used in individual storage/use cases)
   a. Chlorine Dioxide Storage and Operating Area.
      i. The chlorine dioxide facility shall be physically located in a separate room from other water treatment plant operating areas.
      ii. The chlorine dioxide area shall have a ventilation system separate from other operating areas.
      iii. Provision shall be made to ventilate the chlorine dioxide facility area and maintain the ambient air chlorine dioxide concentrations below the Permissible Exposure Limit (PEL).

I. The ventilating fan(s) take suction near the floor, as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air inlets of any rooms or structures.
II. Air inlets are provided near the ceiling.
III. Air inlets and outlets shall be louvered.
IV. Separate switches for the fans are outside and near the entrance of the facility.

iv. The area housing chlorine dioxide facility shall be constructed of non-combustible materials such as concrete.
v. There shall be an ambient air chlorine dioxide sensor in the vicinity of the chlorine dioxide operating area. The ambient air chlorine dioxide readouts and alarm or warning light shall be audible and visible in the operating area and on the outside of the door to the operating area. The design shall include distinguishing audible alarms that are triggered by the ambient air chlorine dioxide sensor readings.
vi. There shall be observation windows through which the operating area can be observed from outside the room to ensure operator safety.
vii. Manual switches to the light in the operating area shall be located outside the door to the room.
viii. There shall be an emergency shower and eyewash outside and close to the door to the operating area.
ix. An emergency shutoff control to shut flows to the generator shall be located outside the operating area.
x. The design shall minimize the possibility of chlorite leaks.
xi. The chlorite tank and chlorine dioxide solution tank shall be vented to the outdoors away from any operating areas.
xii. Gaseous chlorine feed to the chlorine dioxide generator shall enter the chlorine dioxide facility area through lines which can only feed to vacuum.
xiii. The floor of the chlorine dioxide facility area shall slope to a sump.
xiv. There shall not be any open drains in the chlorine dioxide operating area.

xv. Provide secondary containments with sumps for chlorine dioxide storage, and chlorine dioxide solutions which can hold the entire volume of these vessels. This containment shall prevent these solutions from entering the rest of the operating area.

xvi. Provide wash-down water within the operating area.

xvii. The operating area shall be designed to avoid direct exposure to sunlight, UV light, or excessive heat.

b. Chlorine gas

i. Chlorinators should be housed in a room separate from but adjacent to the chlorine storage room.

ii. Both the chlorine gas feed and storage rooms should be located in a corner of the building on the prevailing downwind side of the building and be away from entrances, windows, louvers, walkways, etc.

iii. Chlorinator rooms should be heated to 60 degrees F, and be protected from excessive heat. Cylinders and gas lines should be protected from temperatures above that of the feed equipment.

iv. Chlorine gas feed and storage shall be enclosed and separated from other operating areas. Both the feed and storage rooms shall be constructed so as to meet the following requirements:

I. a shatter resistant inspection window shall be installed in an interior wall;

II. all openings between the rooms and the remainder of the plant shall be sealed;

III. doors shall be equipped with panic hardware, assuring ready means of exit and opening outward only to the building exterior;

IV. a ventilating fan with a capacity to complete one air change per minute when the room is occupied; where this is not appropriate due to the size of the room, a lesser rate may be considered;

V. the ventilating fan shall take suction near the floor and as great a distance as is practical from the door and air inlet, with the point of discharge located so as not to contaminate air inlets to any rooms or structures;

VI. air inlets with corrosion resistant louvers shall be installed near the ceiling;

VII. air intake and exhaust louvers shall facilitate airtight closure;

VIII. separate switches for the ventilating fan and for the lights shall be located outside and at the inspection window. Outside switches must be protected from vandalism. A signal light indicating ventilating fan operation shall be provided at each entrance when the fan can be controlled from more than one point;

IX. vents from chlorinator and storage areas must be screened and discharge to the outside atmosphere, above grade;

X. floor drains are discouraged. Where provided, the floor drains must discharge to the outside of the building and not be connected to other internal or external drainage systems, and;

XI. provisions must be made to chemically neutralize chlorine gas where feed and/or storage is located near residential or developed areas in the event of any measured chlorine release. The equipment must be sized to treat the entire contents of the largest storage container on site.

v. Chlorine gas feed systems shall be of the vacuum type and include the following:

I. vacuum regulators on all individual cylinders in service;

II. service water to injectors/educators shall be of adequate supply and pressure to operate feed equipment within the needed chlorine dosage range for the proposed system.

vi. Pressurized chlorine feed lines shall not carry chlorine gas beyond the chlorinator room.

vi. All chlorine gas feed lines located outside the chlorinator or storage rooms shall be installed in air tight conduit pipe.

vii. Full and empty cylinders of chlorine gas shall meet the following requirements:

I. housed only in the chlorine storage room;

II. isolated from operating areas;

III. restrained in position;

IV. stored in locked and secure rooms separate from ammonia storage, and;

V. protected from direct sunlight or exposure to excessive heat.

c. Acids and caustics

i. Acids and caustics shall be kept in closed corrosion-resistant shipping containers or bulk liquid storage tanks.

ii. Acids and caustics shall not be handled in open vessels, but should be pumped in undiluted form to and from bulk liquid storage tanks and covered day tanks or from shipping containers through suitable hoses, to the point of treatment.

d. Sodium Chlorite for chlorine dioxide generation shall meet AWWA Standard B303-10 or latest revision
    i. Sodium Chlorite shall be stored by itself in a separate room and preferably shall be stored in an outside building detached from the water treatment facility. It shall be stored away from organic materials because many materials will catch fire and burn violently when in contact with sodium chlorite.
    ii. The storage structures shall be constructed of noncombustible materials.
    iii. If the storage structure must be located in an area where a fire may occur, water must be available to keep the sodium chlorite area cool enough to prevent heat induced explosive decomposition of the sodium chlorite.
    iv. Care should be taken to prevent spillage.
    v. An emergency plan of operation should be available for the clean up of any spillage.
    vi. Storage drums must be thoroughly flushed to an acceptable drain prior to recycling or disposal.
    vii. Positive displacement feeders shall be provided.
    viii. Tubing for conveying sodium chlorite or chlorine dioxide solutions shall be Type 1 PVC, polyethylene or materials recommended by the manufacturer.
    ix. Chemical feeders may be installed in chlorine rooms if sufficient space is provided or in separate rooms meeting the requirements of subsection v
    x. Feed lines shall be installed in a manner to prevent formation of gas pockets and shall terminate at a point of positive pressure.
    xi. Check valves shall be provided to prevent the backflow of chlorine into the sodium chlorite line.

e. Sodium hypochlorite:
    i. Sodium hypochlorite shall be stored in the original shipping containers or in sodium hypochlorite compatible bulk liquid storage tanks.
    ii. Storage containers or tanks shall be located out of the sunlight in a cool area and shall be vented to the outside of the building.
    iii. Wherever reasonably feasible, stored sodium hypochlorite shall be pumped undiluted to the point of addition. Where dilution is unavoidable, deionized or softened water should be used.

iv. Storage areas, tanks, and pipe work shall be designed to avoid the possibility of uncontrolled discharges and a sufficient amount of appropriately selected spill absorbent shall be stored on-site.
v. Reusable sodium hypochlorite storage containers shall be reserved for use with sodium hypochlorite only and shall not be rinsed out or otherwise exposed to internal contamination.
vi. Positive displacement pumps with sodium hypochlorite compatible materials for wetted surfaces shall be used. To avoid air locking in smaller installations, small diameter suction lines shall be used with foot valves and degassing pump heads.
vii. In larger installations flooded suction shall be used with pipe work arranged to ease escape of gas bubbles.
viii. Calibration tubes or mass flow monitors which allow for direct physical checking of actual feed rates shall be provided.
ix. Injectors shall be made removable for regular cleaning where hard water is to be treated.

4. Miscellaneous
   a. Provide secondary containment, a sump, wash-down water, and a shower and eyewash at the bulk delivery transfer point.
   b. Finished water shall be used for chlorine dioxide generation.
   c. The finished water line to the chlorine dioxide generator shall be protected with a high hazard assembly.
   d. Provide a water supply near the storage and handling area for cleanup.
   e. The parts of the chlorine dioxide system in contact with the strong oxidizing or acid solutions shall be of inert material.
   f. The design shall provide the capability to shut off the chlorine dioxide operation remotely, i.e., from a location that is outside of the chlorine dioxide operating area.

L. UV Light

1. General This section shall apply to the public drinking water systems that use ultraviolet (UV) disinfection for inactivation of Cryptosporidium, Giardia, and virus. The Director may reduce the requirements on a case by case basis for the water systems that use UV as ancillary means of disinfection and do not claim credit for UV disinfection or for water systems using UV without a SCADA system such as small non-community systems (see section n below).

   Terminology used in this section is based on the definitions in the EPA Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water

Treatment Rule (2006 Final UVDGM). All covered items shall meet AWWA Standard F110-12 or latest revision.

a. Water systems using surface water or ground water under the influence of surface water shall not use UV as the sole means of disinfection. For these types of water systems, at least one alternative primary disinfectant must be used for virus disinfection, and a secondary disinfectant shall be provided to maintain a disinfectant residual in the distribution system.

b. The following requirements apply to the water systems that wish to receive credit for UV disinfection:

   i. The water system shall submit a UV plan which clearly identifies the dose monitoring strategy, such as the UV intensity set point approach, the calculated dose approach or an alternative approach.
   ii. The water system shall identify the goals for the UV facility as part of a comprehensive disinfection strategy, including target pathogens, target log inactivation, and corresponding required UV dose per the latest revision of EPA guidance documents.
   iii. The water system shall submit a UV reactor validation report in accordance with the latest revision of EPA guidance documents to the Director for review prior to installation of UV facility.
   iv. The water system must demonstrate that the reactor is delivering the required UV dose using a validated dose monitoring system and continue to comply with the monitoring and reporting requirements specified in the latest revision of EPA Guidance or Rule.

2. Validation Testing. - The Director may accept a validation report that was conducted based on the 2003 draft UV Disinfection Guidance Manual on a case-by-case basis.

   a. Each model and specific configuration of UV reactor must undergo off-site, full-scale validation testing by an independent third party test facility prior to being approved for use. The validation testing shall be conducted in qualified test facilities that are deemed acceptable by NSF, EPA, or the Director.

b. Validation testing results shall provide data, including calculations and tables or graphical plots, on dose delivery by the UV reactor under design conditions of flow rate, UV transmittance (UVT), UV intensity, lamp status, power ballast setting, as well as consideration of lamp aging and lamp fouling. The validation report shall demonstrate that the monitoring algorithm is valid over the range expected with the application. The data is used to define the dose monitoring algorithm for the UV reactor and the operating conditions that can be monitored by a utility to ensure that the UV dose required for a given pathogen inactivation credit is delivered.

c. The UV reactor validation report shall include:

    i. Description of the reactor and validation test set-up, including general arrangement and layout drawings of the reactor and validation test piping arrangement.
    ii. Description of the methods used to empirically validate the reactor.
    iii. Description of the dose monitoring equation for the reactor to achieve the target pathogen inactivation credit and related graphical plots showing how the equation was derived from measured doses obtained through validation testing under varying test conditions.
    iv. Range of validated conditions for flow, UVT, UV dose, and lamp status.
    vi. Description and rationale for selecting the challenge organism used in validation testing, and analysis to define operating dose for pathogen inactivation credit.
    vii. Tabulated data, analysis, and Quality assurance/quality control (QA/QC) measures during validation testing.
    viii. A licensed professional engineer's third party oversight certification indicating that the testing and data analyses in the validation report are conducted in a technically sound manner and without bias.

ix. The validation report shall be companied with completed Checklists 5.1 through 5.5 included in the EPA Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule (2006 Final UVDGM).

3. Unit Design Criteria
   a. A water system considering UV disinfection shall gather sufficient water quality data prior to design. The water samples shall be representative of the source water to be treated by the UV facility. Frequent testing may be required if significant variation or seasonal trending in water quality is expected.
   b. The following water quality parameters shall be considered in UV facility planning:
      i. UV Transmittance or UV Absorbance
      ii. Calcium
      iii. Alkalinity
      iv. Hardness
      v. Iron
      vi. Manganese
      vii. Turbidity
      viii. pH
      ix. Oxidation-Reduction Potential (ORP)
      x. Particle content and algae
   c. The design flow rate and UVT used to size the UV system shall be selected to provide the required dose at least 95 percent of the time, accounting for seasonal variations of flow and UVT combinations. Specifying a matrix of flow and UVT conditions for the UV reactors may be necessary.
   d. The water system may consider increasing the delivered dose beyond the required UV dose to provide flexibility and conservatism.
   e. UV reactor inlet and outlet configurations shall meet the validated hydraulic distribution of flow conditions or be more hydraulically conservative.
   f. The UV disinfection system shall be capable of applying the required design dose with a failed or out-of-service reactor. The design shall account for an on-line backup

UV reactor or an operating scheme to apply the design dose with one reactor out of service.

g. It shall be possible to isolate each reactor for maintenance.
h. Signals and alarms shall be provided for the operation of the UV facility for the parameters necessary for dose monitoring algorithm, such as low UV dose, high flow rate, low UVT, UVT monitoring failure, UV sensor failure, off specification event, Ground Fault Interrupt (GFI), high water temperature, and low water level.
i. All materials used in constructing or coating the UV reactors that come in contact with water shall be certified NSF Standard 61 - Drinking Water System Components - Health Effects.
j. Any chemicals used in the cleaning of the UV reactor components in contact with the drinking water such as quartz sleeves shall be certified as meeting the ANSI/NSF Standard 60 - Drinking Water Treatment Chemicals - Health Effects.
k. A flow or time delay shall be provided to permit a sufficient time for tube warm-up, per manufacturer recommendations, before water flows from the unit upon start up. The flow or time delay shall be included in the design so they do not result in excessive off specification conditions.
l. A backup power supply of sufficient capacity shall be provided for the UV disinfection system. If power quality problems are anticipated, power conditioning equipment, such as uninterruptible power supply (UPS), shall be included in the design.
m. The design shall include a redundant disinfection mechanism that will apply an approved primary disinfectant to achieve the CT or log removal/inactivation required for compliance if a UV facility is off specification or offline within a maximum response time of 15 minutes. One example of such response is to shut down the off-specification UV train and either bring a parallel UV train on line or initiate a back-up primary disinfection system within 15 minutes, so the continuous duration of an off-specification event is limited to no more than 15 minutes.
n. UV disinfection units for small unapproved non community, transient systems shall be certified as meeting the ANSI/NSF Standard 55, Class A, or other equivalent or

more stringent validation or certification standards that are deemed acceptable by the Director.

o. The dose monitoring approach used for UV facility must be reviewed and accepted by the Director. Typically the calculated dose approach is suitable for large systems or systems with significant flow variation, and the UV intensity setpoint approach is for small systems or systems with fixed flow rate. The dose monitoring approaches need to be consistent with the guidelines stated in the 2006 Final UVDGM or latest revision.

p. If Programmable Logic Controller (PLC) or SCADA interface is used for UV reactor's process control, the programming shall be in accordance with the validated dose monitoring algorithm and the validated conditions. The algorithm shall use inputs of flow, UV intensity sensor readings, lamps status, and/or UVT equal to or more conservative than values measured during the operation of the UV system. If the measured UVT is above the validated range, the maximum validated UVT shall be used as the input to the dose algorithm. If the measured flow rate is below the validated range, the minimum validated flow rate shall be used as the input to the dose algorithm. If the dose algorithm uses relative lamp output determined from the UV intensity sensor readings as an input, the relative lamp output shall be based on the measured UVT, even if it exceeds the maximum validated UVT.

q. The UV reactor's PLC or microprocessor shall be programmed to record off specification events for the following conditions:

   i. Delivered UV dose less than the required dose,
   ii. Flow greater than the validated range,
   iii. UVT less than the validated range,
   iv. Lamp status outside the validated range,
   v. Failure of UV sensors, flow meters, or on-line UVT monitors used in the dose calculation. Laboratory measurements of UVT may be used temporarily in the program until the on-line UVT monitor is repaired.

4. Operation and Maintenance – The operation and maintenance tasks and the frequency of performing them can be specific to the UV equipment installed. The water systems with approved UV installations should follow the manufacturer's recommendation or the

operation and maintenance guidelines stated in Section 6.2 through 6.5 of the 2006 Final UVDGM or latest revision.

a. Startup testing.
   i. The UV reactor manufacturer must provide a site-specific operation and maintenance manual, which shall include the procedure for starting up and shutting down the UV treatment system.
   ii. Provide schedules and performance standards for start-up testing and initial operation. Schedules shall include anticipated start-up date and proposed testing duration. Performance standards shall reference applicable regulations and specific equipment capabilities.
   iii. Operators shall receive site-specific training on the operation of the UV disinfection system.
b. An incident plan shall be developed to address lamp breakage and release of mercury, response to alarms, power supply interruptions, activation of standby equipment, failure of systems, etc.
c. To verify that the UV reactors are operated within the validated limits, selected parameters shall be monitored. The routine operation and maintenance shall include the monitoring and calibration requirements approved by the Director. For very small UV systems, the Director may consider granting exception to allow reduced monitoring and reporting on a case-by-case basis.

M. Ammonia

Ammonia for chloramine formation may be added to water either as aqua ammonia or as anhydrous ammonia (purified 100% ammonia in liquid or gaseous form). Special provisions required for each form of ammonia are listed below.

1. Aqua ammonia (ammonium hydroxide)

   Aqua ammonia feed pumps and storage shall be enclosed and separated from other operating areas. The aqua ammonia room shall be equipped as in Section J.B. Chlorine gas with the following changes:

   a. Corrosion resistant, closed, unpressurized tank shall be used for bulk liquid storage and day tanks, vented through inert liquid traps to a high point outside.
   b. An incompatible connector or lockout provisions shall be provided to prevent accidental addition of other chemicals to the bulk liquid storage tank(s).

c. The bulk liquid storage tank(s) shall be designed to avoid conditions where temperature increases cause the ammonia vapor pressure over the aqua ammonia to exceed atmospheric pressure. Such provisions shall include either:

i. refrigeration or other means of external cooling, and/or;

ii. dilution and mixing of the contents with water without opening the bulk liquid storage tank.

d. An exhaust fan shall be installed to withdraw air from high points in the room and makeup air shall be allowed to enter at a low point.

e. The aqua ammonia feed pump, regulators, and lines shall be fitted with pressure relief vents discharging outside the building away from any air intake and with water purge lines leading back to the headspace of the bulk storage tank.

f. The aqua ammonia shall be conveyed direct from a day tank to the treated water stream injector without the use of a carrier water stream unless the carrier stream is softened.

g. The application point should be placed in a region of rapid, preferably turbulent, water flow.

h. Provisions should be made for easy access for removal of calcium scale deposits from the injector.

i. Provision of a modestly-sized scrubber capable of handling occasional minor emissions should be considered.

2. Anhydrous ammonia

Anhydrous ammonia is readily available as a pure liquefied gas under moderate pressure in cylinders or as a cryogenic liquid boiling at -15 Celsius at atmospheric pressure. The liquid causes severe burns on skin contact.

a. Anhydrous ammonia and storage feed systems (including heaters where required) shall be enclosed and separated from other works areas and constructed of corrosion resistant materials.

b. Pressurized ammonia feed lines should be restricted to the ammonia room and any feed lines located outside the room should be installed in air tight conduit pipe.

c. An emergency air exhaust system, as in Section J.B. Chlorine Gas but with an elevated intake, shall be provided in the ammonia storage room.

d. Leak detection systems shall be provided in all areas through which ammonia is piped.

e. Special vacuum breaker/regulator provisions must be made to avoid potentially violent results of backflow of water into cylinders or storage tanks.

f. Carrier water systems of soft or pre-softened water may be used to transport ammonia to the application point and to assist in mixing.

g. The ammonia injector should use a vacuum eductor or should consist of a perforated tube fitted with a closely fitting flexible rubber tubing seal punctured with a number of small slits to delay fouling by lime or other scale deposits.

h. Provision should be made for the periodic removal of lime or other scale deposits from injectors and carrier piping.

i. Consideration shall be given to the provision of an emergency gas scrubber capable of absorbing the entire contents of the largest anhydrous ammonia storage unit whenever

N. Disinfection of Treatment Facilities

The disinfection procedure should meet the current AWWA standard (C653). A solution strength of 50 mg/l free chlorine applied for 24 hours is recommended. The discharge of highly chlorinated water will require a permit from the Department of Environmental Quality, Office of Pollution Control. At least one clear microbiological water sample shall be collected by a representative of the Mississippi State Department of Health, the Licensed Professional Engineer in charge of the project, or the Certified Operator for the public water supply. Samples with “No Coliform Present” shall constitute acceptable sample(s) when analyzed by the Mississippi State Department of Health or a laboratory certified by the State.

O. Other

1. Process diagrams may be required for certain complex treatment processes.
2. All plant piping should be color coded in accordance with recommendations published in "Recommended Standards for Water Works", 1992 issue.
3. All controls for sources, water levels, etc. should be accessible from the treatment plant.
4. An alternate power source should be considered in case of power loss.
5. Any discharges from water treatment facilities will be regulated by the Mississippi Department of Environmental Quality, Office of Pollution Control.

6. All Water Treatment Plants shall have a security fence around the perimeter. This fence should be at least 6 feet tall with barbed wire around the top.
7. All new or rehabilitated treatment facilities shall include the addition of a ¾ inch sampling faucet to be installed at a point where adequate mixing of finished water has occurred at a distance of no less than 100 feet from the last entry point where chemical(s) are introduced.
   a. It shall be tapped directly to the water main and be a non-hose bib design.
   b. It shall have its access limited to water system personnel only.
8. Deviations from treatment minimum design criteria may be granted with appropriate justification for the needed variation.
9. All permanent treatment facilities shall have a security fence around the perimeter. This fence should be at least 6 feet tall with barbed wire around the top.

Part V – Water Distribution

A. Distribution System Design

1. Pressures

The distribution system shall be so designed as to maintain a minimum dynamic pressure of 20 psi and a maximum static pressure of 80 psi. In certain situations, significant elevation differences may dictate that higher pressures beyond 80 psi within the service area may be necessary. When evident, higher pressures may be considered on a case by case basis provided individual pressure reducers are used on the services.

2. Pipe Sizes

All water mains should be designed based on hydraulic analysis using an appropriate friction coefficient.

a. The maximum Hazen-Williams C value to be used is 120 unless minor losses are calculated for new PVC pipe (allowable C value is 130). Any system with all PVC distribution pipe may use AWWA C value error factors stated in AWWA Manual M11 for pipe greater than 12 inches in diameter.

b. The minimum main size should be 4 inches regardless of the results of the hydraulic analysis. Smaller lines may be considered for low flow areas on a case by case basis if water age will result in excessive flushing requirements.

c. The minimum main size supplying fire hydrants with pumper connections should be as determined by hydraulic analysis using fire flows, but not less than 6 inches. Flushing (2-way) hydrants may be installed on 4 inch lines if the hydraulic analysis demonstrates satisfactory pressure under fire flow conditions.

d. The maximum velocity in all source, treatment and distribution system piping should be limited to 5 feet per second to minimize friction loss. In situations where pump discharge or other metal pipe installations warrant higher maximum velocities, case by case approvals may be allowed with sufficient supporting evidence submitted by the Engineer.

3. Materials

All materials not specifically referenced in these guidelines shall be non-toxic and approved for use in potable water systems by AWWA, U.S. EPA, Underwriters Laboratory, National Sanitation Foundation or other appropriate organization.

a. Ductile iron and steel pipes and fittings shall comply with the latest applicable standards issued by the American Water Works Association.

b. PVC pipe shall bear the National Sanitation Foundation seal for potable water and meet the requirements of ASTM D 1784 for Class 12454 A or 12454 B compounds. The pipe shall meet the latest revision of the applicable AWWA or Commercial Standards. If excess surge pressure is anticipated in special cases, careful consideration should be given to the level of safety in the selection of pipe and materials.

c. For static pressures up to 80 psi, 160 psi pipe (SDR 26) may be used. For static pressures greater than 80 psi, 200 psi pipe (SDR 21) should be used.

d. High Density Polyethylene (HDPE) pipe shall bear the National Sanitation Foundation seal for potable water and meet the requirements of ASTM D3350 and ASTM D2837. The hydrostatic design basis (HDB) of the PE materials shall be established in accordance with PPI TR-3. The pipe shall meet the latest revision of the applicable AWWA (currently AWWA C906-07) and PPI (Plastics Pipe Institute). Pipe shall be PE 3408 SDR 17 or thicker. PE 3408 SDR 21 pipe may be approved for lower operating pressure and temperature on a case by case basis.

e. Fusion Fittings are usually joined to polyethylene (HDPE) pipe by thermal fusion. Properly designed PE fittings may connect to other types of pipe by mechanical methods, such as compression or flange, according to the latest version of AWWA C906-07. Polyethylene fittings may be molded, thermoformed from pipe sections, or fabricated by heat fusion joining polyethylene components prepared from pipe, molded fittings, thermoformed pipe, or polyethylene sheet or block as described in the latest version of AWWA C906-07. Molded fittings shall meet the requirements ASTM D2683 for socket-type fittings, ASTM D3261 for butt-type fittings, or ASTM F1055 for electrofusion-type fittings.

f. Asbestos cement pipe will not be approved by this office and any existing asbestos cement pipe should be replaced.

4. **Consecutive Water Systems**

Water supplies which meter water through a master meter should use a compound meter unless flows are continually maintained at a rate which will register accurately on the meter. Deviations from this will be considered on a case-by-case basis.

B. Installation

1. Pipe Laying

Pipe installation should comply with generally accepted standards of good workmanship, including applicable AWWA and industry standards, along with, but not limited to the following:

a. A continuous uniform bedding should be provided, free of stones and debris within 6 inches of the pipe in the bedding and cover material.

b. There should be a minimum of 30 inches of cover.

c. While under construction, unattended exposed pipelines must have the ends capped. All materials to be used in construction shall be stored above the ground in a manner that will minimize the possibility of contamination.

d. Water mains should be installed to ensure adequate separation from other utilities such as electrical, telecommunications, and natural gas lines for the ease of rehabilitation, maintenance, and repair of water main.

e. Detectable marking tape or tracer wire should be installed on all new pvc water mains to aid in the location of these lines in the future. It is recommended that the tape be blue in color.

f. In areas where aggressive soil conditions are suspected or known to exist, analyses shall be performed to determine the actual aggressiveness of the soil. If soils are found to be aggressive, action shall be taken to protect metallic joint restraints and the water main, such as encasement in polyethylene, provision of cathodic protection, or use of corrosion resistant materials (can be used instead of testing).

2. Polyethylene piping (HDPE) may be joined by thermal butt fusion, socket fusion, electrofusion, flange assemblies, or mechanical methods according to the latest version of AWWA C906-07. Polyethylene piping shall not be joined by solvent cements, adhesives (such as epoxies), or threaded-type connections. Joining methods shall meet the design pressure of the proposed piping system according to PPI standards. In situations where different kinds of polyethylene piping materials must be joined to each other, the manufacturer's specifications for pipe and fittings should be consulted to determine the appropriate fusion procedures. Joining methods shall generally adhere to methods described in AWWA Manual M55 and PPI TR-33.

3. Separation of Water and Sewer Mains

a. Water mains shall be located on opposite sides of the street from sewers where possible.

b. Adequate separation of water and sewer lines shall be based on the following factors:

i. Materials and type of joints for water and sewer pipe.

ii. Soil conditions.

iii. Natural drainage and subsurface flow.

iv. Any other local condition affecting the construction, maintenance or future integrity of the installation.

c. Water mains located near sewer lines.

i. Water mains shall be laid at least 10 feet horizontally **and** 18 inches vertically from any sanitary sewer or manhole. The bottom of the water line should be at least 18 inches from the top of the sewer line. (Water lines should always be constructed above sewer lines. Under extraordinary circumstances, the Bureau of Public Water Supply may approve the construction of a sewer line above a water line provided the design engineer meets special construction requirements as determined by the Bureau.

ii. Where local conditions prevent adequate horizontal and vertical separation, the Bureau of Public Water Supply may allow the water line to be laid closer to the sewer line if supported by adequate data from the design engineer. Each situation will be reviewed on a case by case basis. A detailed drawing shall be included in the plans for the water line construction submitted to the Bureau of Public Water Supply for review and approval. **Where adequate horizontal and/or vertical separation cannot be maintained, the following requirements shall apply:**

I. If the 10 foot horizontal separation between water and sewer lines cannot be maintained then the water line should be ductile iron with water line joints located at the maximum distance possible from sewer line joints. PVC pipe may be used if it is protected by a steel casing. Also the water and sewer lines must be in separate trenches with adequate space for maintenance. In some cases, special sewer line construction procedures may be required.

II. Where the 10 foot horizontal and 18 inch vertical separation cannot be maintained, condition I. must be met and the sewer line shall be constructed according to water main standards.

III. **NOTE:** Where water lines cross sewer lines, the above requirements will be waived if pipe segments are centered to provide maximum spacing of the joints of both water and sewer lines and a vertical separation of at least 18 inches (water over sewer) is maintained.

d. Water lines and sewer lines should be shown on the same layout sheet whether sewer lines are existing or proposed.

e. Potable water lines shall be clearly and permanently identified where pressure sewer systems exist or where sewers are constructed of water pipe.

4. Surface Water, Ditch and Roadway Crossings

a. Water lines crossing ditches and/or streams where less than 30 inches of cover is maintained should be ductile iron pipe or protected by a steel casing. Adequate support and anchorage should be provided on both sides of the ditch.

b. Exposed stream crossings should be above the 100 year flood.

c. PVC pipe crossing roadways should be protected by a steel casing. This office recommends ASTM A252 or ASTM A139 Grade B or better. Pipe should be 35,000 psi ultimate strength.

d. Casing size should be two diameter sizes larger than the pipe to allow for future expansion. If expansion is not anticipated one diameter size larger may be permitted.

5. Disinfection

a. After completion of the construction and pressure testing of water distribution lines, they shall be flushed and disinfected using at least a 50 mg/l free chlorine solution for 24 hours or as described in the latest revision of AWWA C651. Large volume disposal of this water may require a permit from the Department of Environmental Quality Office of Pollution Control.

b. After completion of the construction and disinfection of water distribution lines, the contractor shall arrange for at least one microbiological water sample to be collected by a representative of the Mississippi State Department of Health, the Licensed Professional Engineer in charge of the project, or the Certified Operator for the system from every dead-end line and every major looped line. Water being collected for testing shall not have a chlorine residual higher than is normally maintained in other parts of the distribution system. No chlorine shall be present which is a result of line disinfection. A sample showing “No Coliform Present” shall constitute a satisfactory sample when analyzed by the Mississippi State Department of Health environmental laboratory or a laboratory certified by the MSDH.

6. Cross Connections

There shall be no physical connection between a potable water system and a non-potable system whereby non-potable water or other liquid contaminants may be caused to enter.

a. An appropriate backflow prevention device shall be installed on each service connection where an existing or potential health hazard exists or where a hazardous hydraulic condition may be allowed to exist.

i. Backflow prevention assemblies shall be installed in a location that provides adequate access for testing and repair of the assembly.

ii. Reduced pressure principle backflow prevention assemblies and double check valve assemblies shall not be located in a pit below ground level.

b. Prior to service being connected to a public water system, all wells or water sources owned or used previously by the potential customer shall be physically disconnected from the plumbing to be supplied by the public water system.

c. Interconnections between approved water supplies to be used in emergencies may be allowed provided no hazardous or potentially hazardous hydraulic conditions would be created by the use of the interconnection.

i. A flow of 50% of the peak design flow may be used to assess the hydraulic conditions with the emergency connection in use.

ii. Bureau of Public Water Supply approval of the interconnection shall be obtained prior to installation.

iii. Two closed gate valves should be used to physically separate the two systems. A riser with a small, protected outlet should be installed to signify operation of the emergency connection or failure of one of the valves. A meter should be installed so records of water usage during an emergency may be determined.

iv. A formal resolution of the governing bodies of each of the water supplies shall be adopted prior to construction of the interconnection. This resolution shall clearly define the terms and conditions governing this interconnection of two public water systems.

6. Booster Stations

a. Booster stations should have the storage (collector) capacity, or inflow under peak hydraulic conditions to provide a peak flow for at least 200 minutes in rural areas.

b. A collector tank should be sized for equalizing storage, with a minimum detention time of 30 minutes based on the difference of influent and effluent for chemical contact.

c. Pumps should be sized to meet the demand of the customers past the booster station using the MSDH demand curve i.e. 50 customers would require 65 connections.

d. A provision for a bypass around the booster station should be installed to allow for bypassing the booster station with temporary facilities as needed for maintenance.

e. Chlorination facilities may be required to maintain adequate chlorine residuals beyond the booster station.

f. Hydraulics indicating peak flows and fill conditions should be included.

7. In-Line Booster Pumps

The use of in-line booster pumps to boost pressure and/or flow within a distribution system is generally not recommended. **In-line booster pumps will not be approved by the MSDH Bureau of Public Water Supply except in cases where it can be shown that the benefit gained will justify the inherent risk associated with pumps used in this manner.** Therefore, approval of in-line booster pumps will be issued on a case-by-case basis dependent upon system hydraulics, fire flow tests, line sizes, proximity to elevated storage, etc. Fire flow tests may not be used as a substitute for hydraulic calculations since pressure gauges are not routinely placed at the system's most vulnerable areas during the tests and dynamic pressures could potentially be dropping below 20 psi. In all instances where an in-line pump is proposed, adequate documentation must be submitted to MSDH by a professional engineer licensed to practice in the state of Mississippi for review and approval prior to installation. **In addition, the engineer must certify, in writing, that, in his professional opinion, the installation of the in-line booster pump will not result in a threat to public health due to low water pressure.** In all cases, a low pressure cut off switch will be required to shut the pump off in the event that the pressure on the inlet side of the pump drops to a predetermined value (The minimum setting for cut off switches shall be 20 psi).

8. Other

a. All water users should be individually metered.

b. A sufficient number of valves should be provided for line maintenance, repairs and isolation of fire hydrants.

c. Flushing hydrants should be installed on all dead end lines, low areas and in other places that might require flushing. They should be installed in areas where 2.5 ft/sec. velocity can be obtained for adequate flushing.

d. Pressure and leakage tests should be completed and conform to the current AWWA Standard C600 (see applicable section for the type of pipe being installed).

e. Blocking - All tees, bends, plugs and hydrants shall be provided with reaction blocking, tie rods or joints designed to prevent movement.

f. Anchoring of fusible pipe - Additional restraint may be necessary on fusible pipe at the connection to appurtenances or transitions to different pipe materials to prevent separation of joints. The restraint may be provided in the form of an anchor ring encased in concrete or other methods as approved by the reviewing authority.

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Part VI – Water Storage

A. General

1. Construction Standards

All welded steel tanks should conform to the current "AWWA Standard for Welded Carbon Steel Tanks for Water Storage". All pressure tanks should conform to current AWWA standards and to the ASME Code for Unfired Pressure Vessels.

2. Overflows and Drains

Overflows and drains shall not be directly connected to sewers or storm drains.

3. Drainage of Surfaces

Surfaces of tanks, including hatch covers, should be sloped to drain.

4. Other Tank Materials

Tanks of materials other than welded steel will be considered on a case by case basis.

5. Coating

a. Paints, primers and sealers used on the interior of water tanks shall be NSF approved for contact with potable water.
b. Coal tar, wax, or bitumastic shall not be used in interior coatings for water tanks. Lead paint shall not be used on the interior or exterior of water tanks.
c. The Division strongly recommends that all painting projects be under the supervision of a licensed professional engineer.

6. Refurbishing/Removal of Coatings

a. Surface preparation - Refer to SSPC requirements. The interior should follow SSPC 10 and the exterior should follow SSPC 6.
b. Coating
    i. Interior - for interior coatings in contact with potable water we recommend a catalyzed epoxy system
    ii. Exterior - for exterior coating we recommend a polyurethane system
c. Lead abatement - Refer to SSPC guidelines.

7. Protection from Trespassers

Fencing, locks on access manholes and other necessary precautions shall be provided to prevent trespassing, vandalism, and sabotage. Consideration should be given to the installation of high strength, cut resistant locks or lock covers to prevent direct cutting of a lock.

8. Disinfection of Sampling

Prior to being placed into service after construction or maintenance, tanks and related piping shall be disinfected and sampled.

a. Prior to disinfection, all foreign material should be flushed from the tank.
b. The disinfection procedure should meet the current applicable AWWA Standard C652, or use water with 50 mg/l of free available chlorine for a contact time of 24 hours. Disposal of highly chlorinated water may require a permit from the DEQ/Office of Pollution Control.
c. Water samples for microbiological analysis must be collected by a representative of the Mississippi State Department of Health, the Licensed Professional Engineer for the project, or the Certified Operator for the public water system. Water being collected for testing should not have a chlorine residual higher than normally maintained in the water system. No chlorine should be present as a result of disinfection.
d. A sample showing "No Coliform Present" shall constitute a satisfactory sample. The sample shall be analyzed by the Mississippi State Department Health environmental laboratory or other State certified laboratory.

B. Hydropneumatic (Pressure) Tanks

1. Sizing

Pressure tanks should be sized in gallons at a minimum of 40 times the pump capacity in gallons per minute to provide a reasonable cycle and detention time.

2. Allowable Pressures

Maximum control pressure range: 20 psi

3. ASME Code Requirements

Tanks should be built to ASME code requirements.

4. Controls

Air volume and pump controls should maintain the water level between 1/3 and ½ diameter measured from the bottom of the tank. Controls should be designed to minimize release of air through the air release valve and maximize pump run time. The controls must sense both air pressure and the water level to maintain proper conditions for providing desired pump cycle, so a combination of pressure and electrode controls is recommended.

5. Piping

When the inlet and outlet are at the same end of the tank, the inlet should extend into the tank a minimum of 2/3 of its length to prevent short-circuiting.

6. Accessories

a. A sight glass should be provided to allow a visual indication of the water level. Valves should be provided to allow drainage of the sight glass.

b. A pressure relief valve shall be provided, set to discharge if the pressure in the tank exceeds normal working pressure. The pressure relief valve should meet ASME Code requirements.

c. A valved bypass line shall be provided so that the tank may be isolated for maintenance.

d. A drain with a resilient seat valve and a horizontal discharge should be provided on the bottom of the tank, sized to allow draining of the tank in a reasonable time.

e. Access to the tank should be provided in the bottom 1/3 diameter of the tank so that the gasket will remain submerged, sized at least 18 inches in the smallest dimension.

f. A weather proof pressure gauge should be mounted above the maximum water level, with an isolation valve.

g. Valved connections for air volume and pressure controls should be provided.

h. An air compressor should be provided to replenish the air being absorbed.

C. Elevated Tanks, Standpipes, and Ground Reservoirs

1. Sizing

a. Elevated storage capacity should be at least 50% of the daily demand. This allows up to two connections per source gpm provided the well operating time is 12 hours or less on peak demand days. Storage less than this requires additional source capacity to provide a peak flow of 1 gpm per connection for an equivalent number of minutes. **NOTE:** The Department of Health strongly encourages all public water systems to provide elevated storage equivalent to one day's normal usage (gallons).

b. Standpipes and reservoirs may be used as elevated storage where elevations allow. The volume of a standpipe above the level required to maintain at least 20 psi dynamic pressure at all connections, as demonstrated by a hydraulic analysis, may be considered elevated storage.

c. Ground level tanks used as pump reservoirs should be sized to provide routine storage plus reserve emergency storage.

d. Absent of hydraulic calculations indicating otherwise, the top 25 feet of a standpipe shall be considered elevated storage.

e. Excessive storage capacity should be avoided to prevent potential water quality deterioration problems.

2. Accessories

a. A water level gauge should be provided to allow a visual indication of the water level in the tank.

b. A screened vent as large as the inlet/outlet pipe shall be provided in accordance with current AWWA standards, to protect the tank from the entrance of insects, birds and other contaminants. The overflow pipe should not be considered a tank vent.

c. An overflow shall be provided in accordance with current AWWA standards.

d. A drain shall be provided, sized to allow draining of the tank in a reasonable period of time.

e. A provision should be made for isolating the tank for inspection and maintenance while maintaining water service.

f. Support columns should have drain plugs.

g. Ladders should be equipped with OSHA approved safety devices.

h. Access into the tank shall be provided according to current AWWA standards. The opening should have a curb at least 4 inches high and the cover should have a downward overlap of at least 2 inches.

i. A 3/4 inch sample faucet shall be provided on the tank riser near its bottom.

j. A manhole should be provided to allow for entrance into the riser. It should be at least 24 inches in diameter.

3. Pre-Owned (Used) Tanks

a. Prior to coating:
   - i. Any pit greater than 1/8" should be welded.
   - ii. Any pit less than 1/8" can be repaired using a NSF approved filler.

b. Extra care should be given to grind all welds. (Existing welds included).

c. The Department strongly recommends that all previously owned elevated tanks be inspected by qualified professionals prior to dismantling.

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Part VII - Hydraulics

Computerized hydraulic calculations should be provided for all project submittals to the MSDH involving the construction of subdivisions or significant water distribution system extensions. In addition, hydraulic calculations may be necessary for submittals on projects such as elevated tanks and wells where the influence of these system components must be ascertained.

Listed below are the minimum requirements that are needed for the submittal of hydraulic information to the MSDH/DWS:

A. Map of the Proposed System

1. Provide a Node Map that is clearly and accurately displayed.
2. The Node Map should include the node numbers and elevations, pipe numbers, the number of customers between each node and the location of each source, tank, booster station and pressure reducing valve. The pressure settings and flows should be indicated for each pressure reducing valve.

B. Selection of Fixed Gradient

1. In selecting the flow gradient of elevated tanks, the Mean Sea Level (MSL) of the overflow should be used.
2. In selecting the flow gradient of hydropneumatic tanks, use the middle range of the tank's operating pressure.
3. In selecting the flow gradient of wells, use the MSL of the overflow of the tank that the well pumps to.

C. Other Requirements

1. Use the MSDH/DWS "Demand Curve" on all lines where the flow is less than 100 gpm.
2. "Fill" hydraulics will be required to ascertain if wells have the capability of filling elevated tanks, standpipes, booster stations and collector tanks.
3. Submittal should include system input data as well as results.
4. Use demand factors as specified in Table 1, "Water Demands", in determining the correct demand for unmetered systems, apartments, trailers and recreational vehicles.

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Part VIII – Safety and Security

All water system facilities shall be designed to include measures to provide protection against vandalism, sabotage, terrorist acts, or access by unauthorized personnel.

A. Protection of Water System Facilities

All finished wells, treatment facilities, pumping structures, and water storage tanks shall be protected from trespassing, unauthorized access and vandalism. Protection measures may include, but are not limited to:

1. Lockable doors and access ways;
2. Secured outdoor electrical and control systems;
3. Windows designed to deter human entrance;
4. Exterior lighting sufficient to provide safe access and deter vandalism and sabotage;
5. Fencing with locked gates. All permanent water system facilities shall have a security fence around the perimeter. New fence installation must be at least 6 feet tall with barbed wire around the top. Existing fencing at facilities may be at least 5 feet tall with barbed wire around the top.
6. Physical barriers to entrance of ladders
7. Provision for ensuring security of the facilities at all times. Incorporation of appropriate intrusion alarms should be provided which can effectively communicate to the operator in charge or system representatives.

B. Project Site Safety

The proximity of residences, industries and other establishments shall be identified and their effect on the safety, security, operation and maintenance of facilities.

1. Projects located in areas that are subject to a significant risk from earthquakes, floods, fires, pollution or other disasters which could cause a breakdown of the public water system shall be designed to protect the facilities to the extent practical.
2. Systems shall not be located on sites with any potential sources of pollution or other factors that may influence the quality of the supply or interfere with effective operation of the water works system, such as sewage absorption systems, septic tanks, privies, cesspools, sinkholes, sanitary landfills, refuse and garbage dumps.

Appendix A - Environmental Standards

Public Water System Secondary Drinking Water Standards

Secondary standards are set for, and the Secondary Maximum Contaminant Level (SMCL) is applied to, those contaminants that affect the aesthetic quality (such as taste, odor, or color) of the water. Water that exceeds the SMCL for these contaminants may not be pleasant to drink, but will cause no health problems.

The Secondary Maximum Contaminant Levels for public water systems are as follows:

Contaminant	Level
Aluminum	0.05 to 0.2 mg/l
Chloride	250 mg/l
Color	15 Color Units
Corrosivity	Non-corrosive
Copper	1.0 mg/l
Fluoride	2.0 mg/l
Foaming Agents	0.5 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	3 Threshold Odor Number (TON)
pH	6.5 - 8.5
Silver	0.10 mg/l
Sulfate	250 mg/l
TDS	500 mg/l
Zinc	5 mg/l

Reference:

"National Secondary Drinking Water Regulations." 40 CFR 143.3. 1991

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Appendix B - Information For Review/Approval of Engineering Plans & Specifications

A. Plans (standard size sheets - 24 x 36 inches, preferably folded) -

1. Title sheet indicating the name of the project.
2. Location and a vicinity map showing certificated area to be reviewed in relation to existing certificated areas. (Mississippi County)
3. Major water lines from the water source (well or storage tank) need to be shown (with sizes and lengths) to the areas to be served.
4. Layout sheet to show location, length and size of water lines, location of sewer lines, lot numbers, location and type of existing potential users.
5. Layout sheet to show design points, contour lines, and/or pertinent elevations, water courses, and other pertinent features.
6. Layout sheet to show locations of valves, fire hydrants, flushing hydrants and service connections.
7. Water detail sheet showing thrust blocking, hydrants, valves, service line connections, etc.
8. If included in the project, the well, storage tank, chlorination and other treatment equipment details need to be shown, including all piping and valving arrangements.
9. Prior to approval of any new extensions or major construction, installation of a master meter on wells or treatment plants will be required if one does not already exist.
10. Additionally, the consultant shall send the plans electronically in pdf form via CD or USB drive in addition to the one 24 x 36 inch set used by the regional engineers in their review. One 12 x 18 inch set (half scale) of plans may be submitted instead of a full scale set provided necessary details are given in the submission. The electronic version should be stamped and signed within the pdf document.

B. Specifications

1. General

a. Appropriate information regarding the proper disinfection of new facilities post construction including necessary sampling requirements
b. Distribution projects shall include the followings:

a. Information regarding the proper separation of water and sewer lines.
b. Information on the proper depth of bury of water lines based on location.
c. Information on the proper method of pressure testing of piping post construction to leakage is in accordance with AWWA Standards.
d. Information for proper microbiological testing and acceptance of system to ensure that the newly constructed distribution meets minimal sanitary requirement for potable water.
e. Complete specifications on pipes, valves, hydrants, etc.
f. Construction methods, including protection of distribution lines from gross contamination during construction.

c. Contract proposal.
d. A transmittal sheet will be required and should be signed by the Responsible Official. For subdivisions and apartment complexes, the number of lots or units should be specified.

2. Well

a. Capacity and head.
b. Anticipated depth and water quality.
c. Casing materials, sizes and lengths.
d. Screen size and lengths.
e. Coating.
f. Pump head foundation size and design.
g. Cementing of casing.
h. Lap pipe and/or seal.
i. Back pressure valve.
j. Venting of casing.
k. Pump information - setting, speed, head, etc.
l. Piping arrangements such as sizes, valves, sampling bib, etc.
m. Provision of a master meter.
n. Controls and operations.

3. Chlorinator and Other Treatment Facilities

a. Type and meter size.
b. Booster pump information such as head, capacity, etc.
c. Piping and valving arrangements.
d. Housing information such as insulation, ventilation, etc.
e. Provision of test kits.

4. Hydropneumatic Tank

a. Size, pressure rating and standards.
b. Coating inside and out.
c. Sight gauge, manhole and drain.
d. Air volume controls and pressure relief valves.
e. Sizes and arrangement of piping and valves.
f. Bypass piping arrangements.

5. Elevated and Ground Storage Tanks

a. Size, type, material and height.
b. Standards to be met, coating inside and out.
c. Height of high and low levels.
d. Overflow arrangement and heights.
e. Drain size and arrangement.
f. Piping and valve size and arrangement of each.
g. Manhole, venting and screening.
h. Controls.

6. Booster Stations

a. Service pump information such as head and capacity.
b. Collector tank size, coating, etc.
c. Pressure tank information (as given above).
d. Information on orifice to fill collector tank.
e. Insulation of pipes.
f. Controls for service pump.

C. Hydraulic Computations

Needed from source to system and throughout the system if it is deemed critical.

D. Administrative Needs

1. Plans and specifications must be prepared by a professional engineer licensed to practice in Mississippi and submitted with the engineer's seal affixed. A minimum of one complete sets of plans and specifications along with the electronic version via CD or other electronic storage method should be submitted for administrative purposes, plus the number the engineer requires for his/her purposes.
2. If obtaining water from a municipality, rural water association or other MSDH approved public water system, a copy of the agreement from the supplier indicating their willingness to serve this area must be submitted.
3. Separate specifications should be bound, sealed and the name of the project shown. If reference is made to standard specifications, a current copy must be on file with the Bureau of Water Supply.
4. If one or more additions or parts are to be added to a project at a later date, an overall layout sheet must be submitted. The original design should be compatible with the proposed addition without excessive duplication of lines or interruption of service. For distribution extensions, an overall layout map should be submitted.
5. Where sewage or sewage treatment facilities are involved, the Mississippi Department of Environmental Quality, Office of Pollution Control must approve these facilities before the water system can be formally approved. A copy of the Office of Pollution Control's approval must be submitted.
6. Subdivisions where individual onsite sewage treatment and disposal systems are proposed shall meet the requirements of the "Regulation Governing Individual Onsite Wastewater Disposal Systems" and the Mississippi State Department of Health policies and procedures related to this regulation.
7. The Mississippi Public Service Commission should be contacted for approval of certificated areas. For new public water systems, the Public Utilities Staff must evaluate the financial and managerially capabilities of the proposed water system and the Department of Health must receive written certification from the Executive Director of the Public Utilities Staff that the proposed new public water system is financially and managerially viable. The Department of Health is prohibited by law from approving new

public water systems until this certification from the Executive Director of the Public Utilities Staff is received.

8. A transmittal sheet will be required and should be signed by the Responsible Official.

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Appendix C - Procedure for Approval of Water Source(s) for Food Production Facilities / Restaurants

This procedure is set for the purposes of approving any water supply source that will be used for the sole purpose for the production of any food or drink that is meant for consumption. Examples of facilities may include but are not limited to restaurants, bottled water plants and breweries.

Preliminary Engineering Report

A. A preliminary engineering report prepared by a registered engineer licensed to practice in Mississippi should be submitted to the Bureau of Public Water Supply in order to facilitate the approval of the proposed water source for the food production facility. This report should include:

1. Proposed site location
2. Information regarding the vulnerability of the water source to contamination
3. Summary and evaluation of results of water quality analyses
4. Recommendation concerning need for water treatment and protection of the water source

Additional information may be required depending upon the specific water source for which approval is requested.

Site Inspection

B. The preliminary engineering report should include the results of a site inspection of the geographical area within the proximity (at least 2 mile radius) of the proposed water supply source. The purpose of this site inspection is to locate any landfills, garbage dumps, industrial sites, oil exploration sites and any other potential contaminant sources that may affect the water source. The proposed location of the water source should be carefully reviewed to determine if it is susceptible to contamination by surface runoff.

Preliminary Water Quality Analyses

C. The preliminary engineering report should include the results of water quality samples collected from the potential water source. The water analyses should include all Safe Drinking Water Act required analyses and a general chemical and physical analysis to determine if treatment of the source will be required prior for use in the food production. These analyses should be completed by an environmental laboratory certified to complete Safe Drinking Water Act analyses for public water supplies. If requested, the Mississippi State Department of Health environmental laboratory will complete the full battery of required water quality analyses for a fee.

D. The preliminary engineering report should be submitted to the Mississippi State Department of Health, Bureau of Public Water Supply for review and comment. After completion of the review and resolution of any noted problems, the Bureau will issue a letter of concurrence with the report.

Completion of Final Plans and Specifications

E. Final plans and specifications of construction for the water source should be provided to the Bureau of Public Water Supply for review and comment.

F. After any noted problems with the submitted plans and specifications have been resolved, the Bureau will issue a letter of approval for construction.

Construction of Water Source

G. Construction of the water source may then be initiated. After construction is completed, the consulting engineer shall certify to the Bureau the project has been constructed according to the approved plans and specifications.

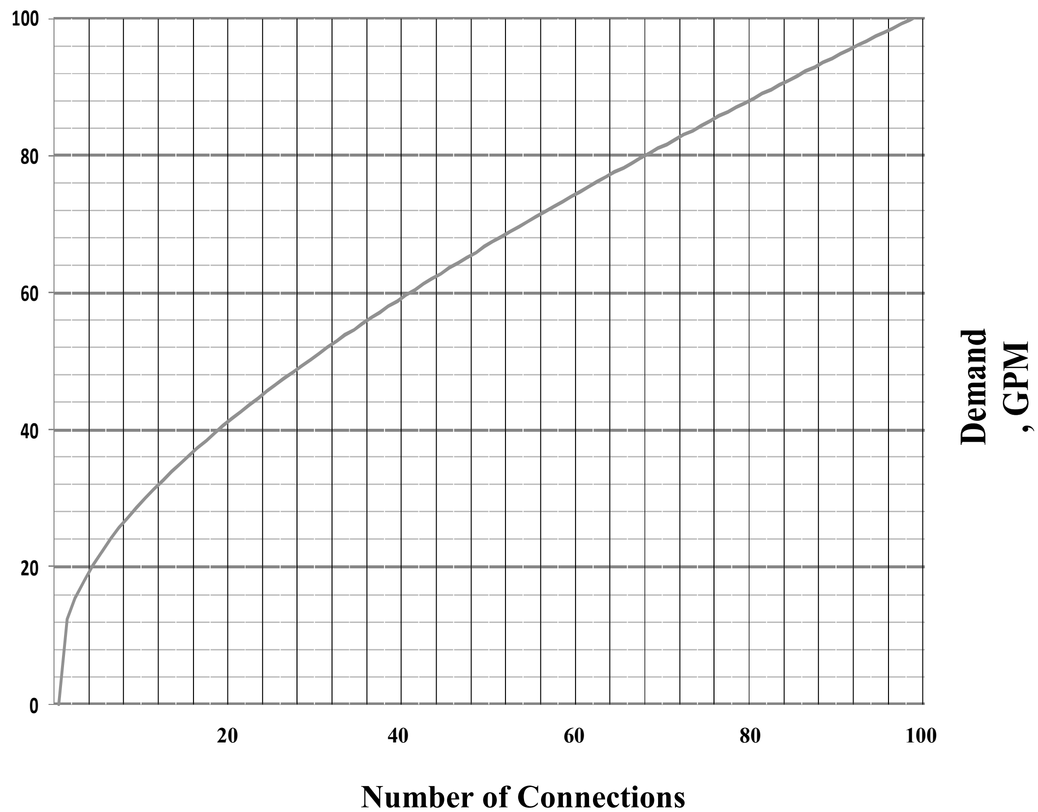
Final Water Quality Analyses

H. A final complete set of required water quality analyses should be completed on the water source. After review of this water quality analyses and based upon the consulting engineer's certification that the project was constructed according to approved plans and specifications, the Bureau will issue a letter of final approval of the water source.

Issuance of Operating Permit

I. The owner of the proposed food production facility can then move forward, working with the Mississippi Department of Health, Milk and Bottled Water Division to meet all additional requirements for the issuance of a permit to operate a food production facility in the State of Mississippi.

Appendix D – Minimum Flow Requirements



Demand Curve

Based on Formula: $GPM = (10)^{10^{\wedge}\ 0.1325\log(conns) + 0.037}$

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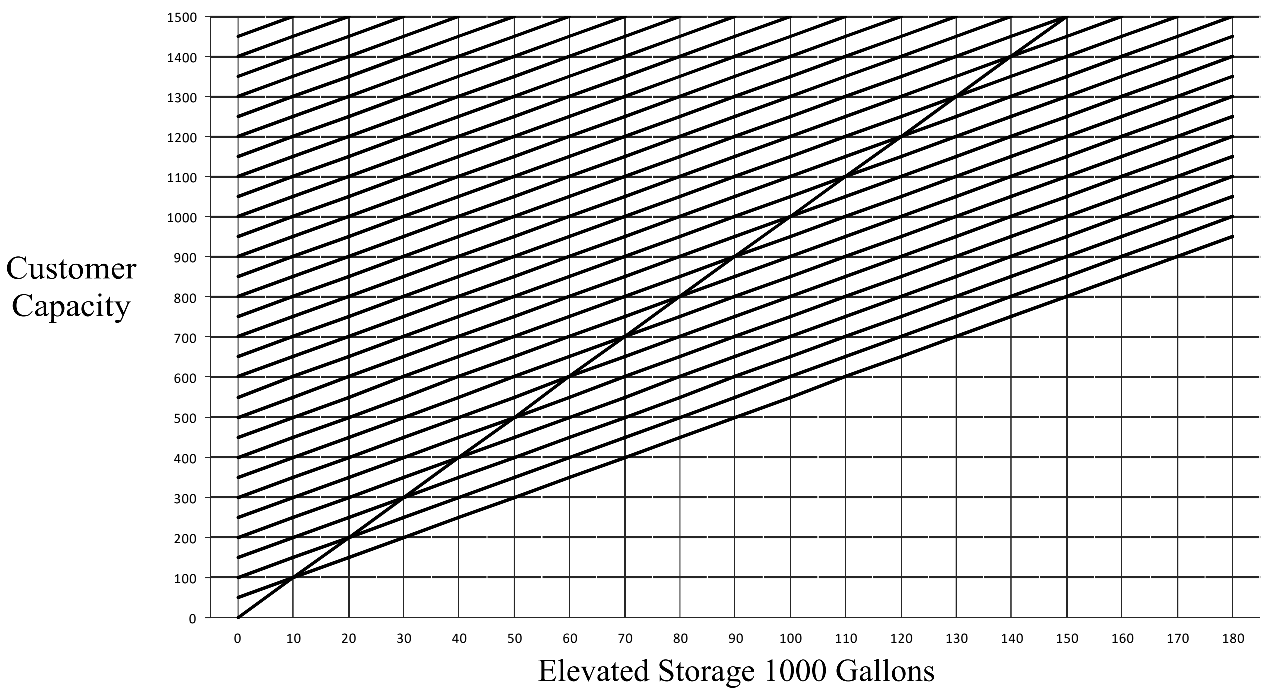
Appendix E – Customer Capacity based on Elevated Storage



C = W + (S/200)

where

C = Customer Capacity

W = Source Capacity, gpm

S = Elevated Storage, gal

Based on the ability to supply peak flow of 1 gpm/connection for 200 minutes.

Consistent with the requirement for 25% of peak daily demand of 400 gal/connection to allow customer capacity of twice the source capacity in gpm.

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Appendix F - Guide for Estimating Average Daily Water Requirements

Type of Establishment **(The unit is per person unless otherwise stated)**	**Average Daily Use** **(gpd)**
Airport (per passenger)	3 - 5
Assembly Halls (per seat)	2
Camps - Children, overnight, central facilities - Construction - Migrant Labor - Day type, no meals served	40 - 50 50 35 - 50 15
Churches (per member)	1
Cottages, season occupancy	50
Clubs - Residential - Non residential	100 25
Factories (sanitary uses, per shift)	15 - 35
Food Service - Restaurants - With bars - Fast food	7 - 10 9 - 12 2
Highway Rest Areas	5
Hotels (2 persons per room)	60
Institutions - Hospitals (per bed) - Nursing Homes (per bed) - Others	250 - 400 150 - 200 75 - 125
Office Buildings	15 - 30
Laundries, self service (per customer)	50
Motels (per bed)	60
Parks - Day use (with flush toilets) - Mobile homes (per unit) - Travel trailers (per unit)	5 200 90 - 100
Picnic Areas (with flush toilets)	5 - 10
Residential Communities - Multi family (per bedroom) - Rooming house and tourist homes	120 120 400

type (per bedroom) - Single family type (per house)	
Resort Motels and Hotels	75 - 100
Retail Stores (per toilet room)	400
Schools - Day (no showers or cafeteria) - Day (with cafeteria) - Day (with showers and cafeteria) - Residential types	15 20 25 75 - 100
Shopping Centers (per sq. ft. sales area)	0.16
Swimming Pools and Beaches	10
Theaters - Drive in (per car) - Others (per seat)	3 - 5 3

Appendix G - Special Requirements for Chlorinator Installations

In certain situations, it is necessary to install gaseous chlorinators that are controlled by solenoid valves rather than booster pumps. Whenever it is necessary to use solenoid valves to control the gaseous chlorinator, the following procedures **must** be followed:

1. Place a wye strainer in the piping upstream of the solenoid valve to ensure that no trash can clog the valve. If a plastic wye strainer is used, it **must** be schedule 80.

2. The solenoid valve should always be the "fail closed" type of valve so that, if power is lost, the valve would be normally in the closed position.

3. Directly wire the solenoid (**i.e. no plug-in connections**) so that no power is on the valve when the well is not pumping water. This requires a direct connection to the starter at the well.

4. If a bypass is provided around the solenoid valve, the bypass **must** remain closed at all times unless the system is being tested or repaired. The bypass should **never** be left open and unattended.

5. If the outlet water level is below the solenoid valve, a corrosion resistant vacuum breaker must be placed after the injector at a level higher than the solenoid valve.

6. A bottle of 56% ammonium hydroxide solution shall be available for detecting chlorine leaks. Where ton containers or tank cars are used, a leak repair kit approved by the Chlorine Institute should be provided. Consideration should be given to the provision of caustic soda solution reaction tanks for absorbing the contents of leaking containers. 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.

7. Scales for weighing cylinders should 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 should be provided. Scales shall be of corrosion-resistant material.

8. 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.

9. Rooms containing disinfection equipment shall be provided with a means of heating so that a temperature of at least 60°F (16°C) can be maintained. The room should be protected from excess heat. Cylinders shall be kept at essentially room temperature.

10. 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 one point.

11. EPA regulations require that any facility having 2,500 pounds of chlorine gas on site develop an approved Risk Management Plan (RMP). Approval of these plans comes under the jurisdiction of the Mississippi Department of Environmental Quality and in accordance with OSHA and EPA guidelines.

Appendix H – Special Requirements for Ozone Installations

Because of its relatively short half-life, ozone is always generated on-site by an ozone generator. The two main principles of ozone generation are UV-light and corona-discharge. Ozone generation by corona-discharge is most common nowadays and has most advantages. Advantages of the corona-discharge method are greater sustainability of the unit, higher ozone production and higher cost affectivity.

UV-light can be feasible where production of small amounts of ozone is desired (e.g. laboratories). An ozone production unit with corona-discharge consists of the following parts: oxygen source, dust filters, gas dryers, ozone generators, contacting units and torch destruction. In the ozone generator, the corona-discharge element is present, which provides a capacitive load. The ozone is produced from oxygen as a direct result of electrical discharge. The corona-discharge ruptures the stable oxygen molecule and forms two oxygen radicals. These radicals can combine with oxygen molecules to form ozone. To control and maintain the electrical discharge, a dielectric is present, carried out in ceramic or glass. The excessive heat of the electrodes is often cooled by cooling water, or by air (figure 1).

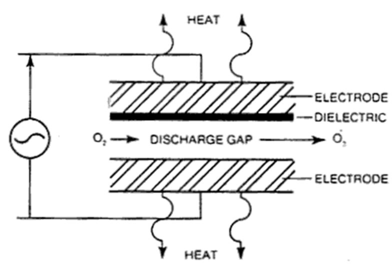

Figure 1: outline corona-discharge generator

For the production of ozone, ambient air can be used (supplied by a compressor) or pure oxygen (supplied by an oxygen generator, or sometimes by oxygen bottles). To condition this air, air dryers and dust filters are used.

To break down the remaining ozone after use, ozone destructors are applied. The mechanism of an ozone destructor can be based on different principles. Usually a catalyst is applied, which accelerates the decomposition of ozone into oxygen (e.g. magnesium oxide).

The generation of ozone is very energy-intensive, with some 90 % of the power supplied to the generator being utilized to produce light, sound and primary heat. Important factors that influence ozone generation are: oxygen concentration in the inlet gas, humidity and purity of inlet gas, cooling water temperature and electrical parameters. To minimize the energy that is used at a high ozone yield, it is important that these factors are optimal.

Cooling water temperature

Ozone generation is accompanied by heat formation. This makes it important to cool the generator. An ozone reaction is reversible and this increases when temperatures rise. As a result, more oxygen molecules are formed:

$$3O_2 \underset{+\Delta T}{\overset{-\Delta T}{\rightleftharpoons}} 2O_3$$

Figure 2 illustrates the relation between cooling water temperature and the yield of ozone generation. This figure shows that an increasing cooling water temperature results in a decreasing ozone production. To limit the decomposition of ozone, the temperature in the discharge gap should not be higher than 25 °C. The general advice is that cooling water may increase 5 °C to 20 °C maximally. It is important that the temperature of the inlet air is not too high.

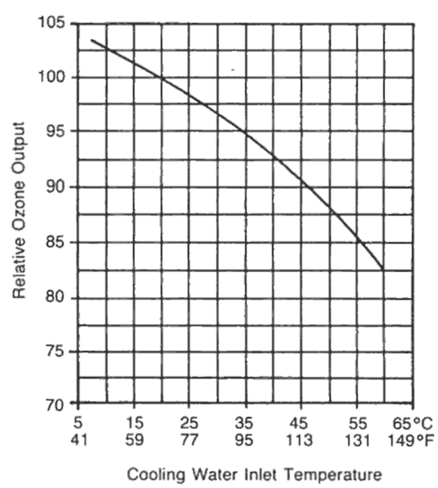

Figure 2: influence of water cooling on ozone generation efficiency

Humidity inlet air

Before the feed gas enters the ozone generator, air dryers should dry the air. Ambient air contains moisture, which reacts with ozone. This leads to a reduction of the ozone yield per kWh. An additional problem of high humidity is that undesired reactions occur in the corona unit. When increased amounts of water vapor are present, larger quantities of nitrogen oxides are formed when spark discharge occurs. Nitrogen oxide can form nitric acid, which can cause corrosion. Furthermore, hydroxy-radicals are formed that combine with oxygen radicals and with ozone. All of these reactions reduce the capacity of the ozone generator.

Figure 3 shows the influence of the humidity on the capacity of an ozone generator. The two descending lines illustrate the capacity of the generator: 'oxygen' for an oxygen-fed generator and 'air' for an air-fed generator. At a dew point of -10 °C, the capacity of the air-fed generator is only 60% of the total achievable capacity. For ozone generators that are oxygen-fed, this capacity is higher; about 85%.

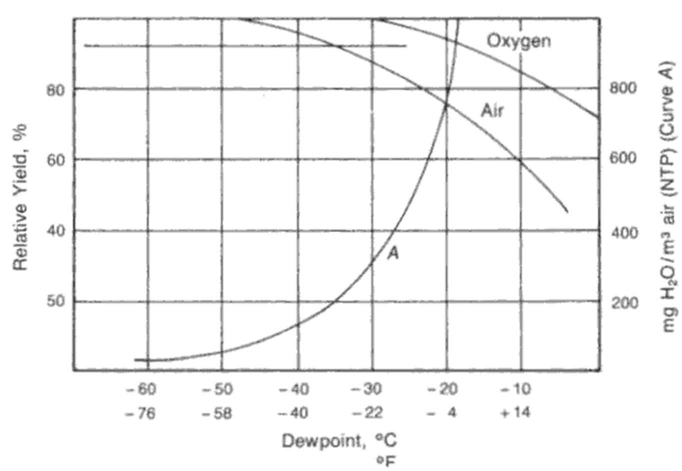

Figure 3: influence humidity inlet air on efficiency of ozone production

To prevent these side-reactions, inlet air first passes a drying chamber before ozone is generated. For drying, an aluminum compound can be used, comparable with silica gel. In an ozone generator two or more drying chambers are used alternately. When a drying chamber is used for a certain period of time, humid air is directed to the other drying chamber, while the first is regenerated.

Purity of gas (inlet)

The presence of organic impurities in gas feed must be avoided, including impurities arising from engine exhausts, leakages in cooling groups, or leakages in electrode cooling systems. The gas supply of the generator must be very clean. An example is given in figure 4, where the concentration of hydrocarbons is related to the ozone yield. This figure shows that at a hydrocarbon concentration of about 1%, the ozone generation nearly approaches zero [5].

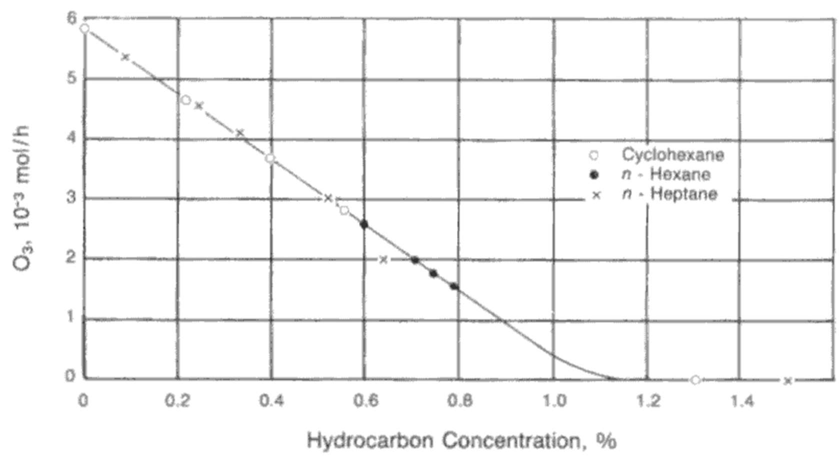

Figure 5: influence of hydrocarbons on the generation yield of ozone

Produced amount of ozone versus oxygen concentration of inlet air

Ozone is produced from oxygen, so it can be produced from ambient air (21 % oxygen) or nearly pure oxygen (e.g. 95 %). Pure oxygen can be generated from ambient air by an oxygen generator. The ozone concentration an ozone generator delivers is dependent on the oxygen concentration (among other things). This is clarified by figure 4, where the oxygen concentration is outlined against the ozone concentration. The diverse lines demonstrate the ozone generators with different energy use. According to the chart, ozone production increases by a factor 1.7 to 2.5 when pure oxygen is used, at constant electrical power.

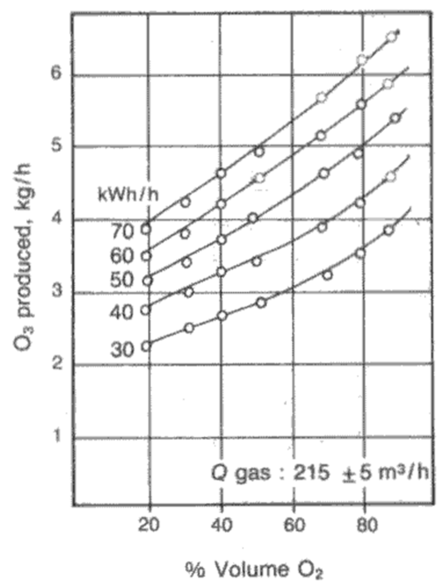

Figure 4: influence of oxygen concentration on ozone production at different electrical current

Typical ozone generation by the corona discharge method(CD)

The following figures show typical corona discharge schematics for vertical and horizontal tubes:

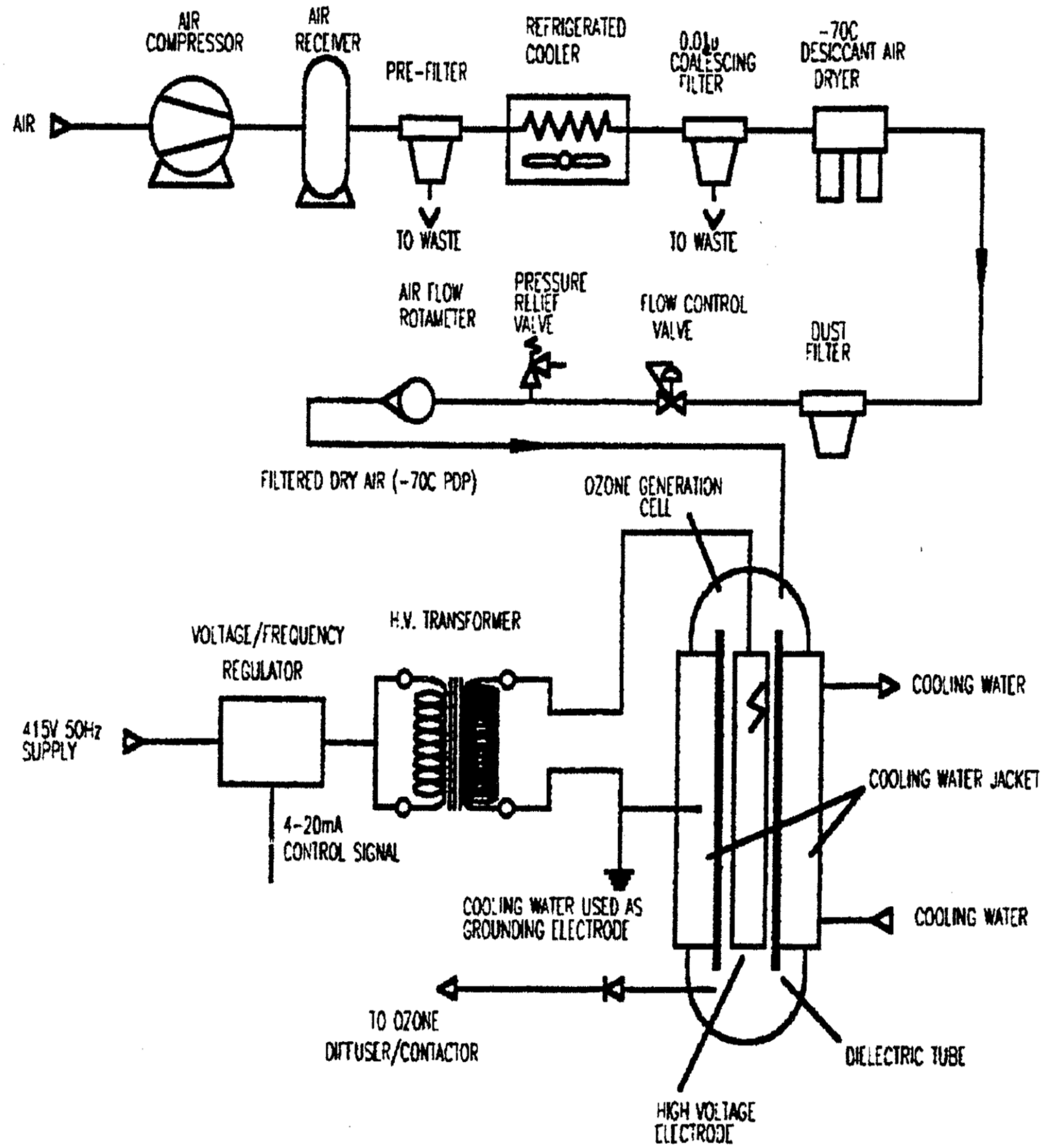

Fig. 1 – Typical Vertical Tube Ozonator Process Flow Schematic

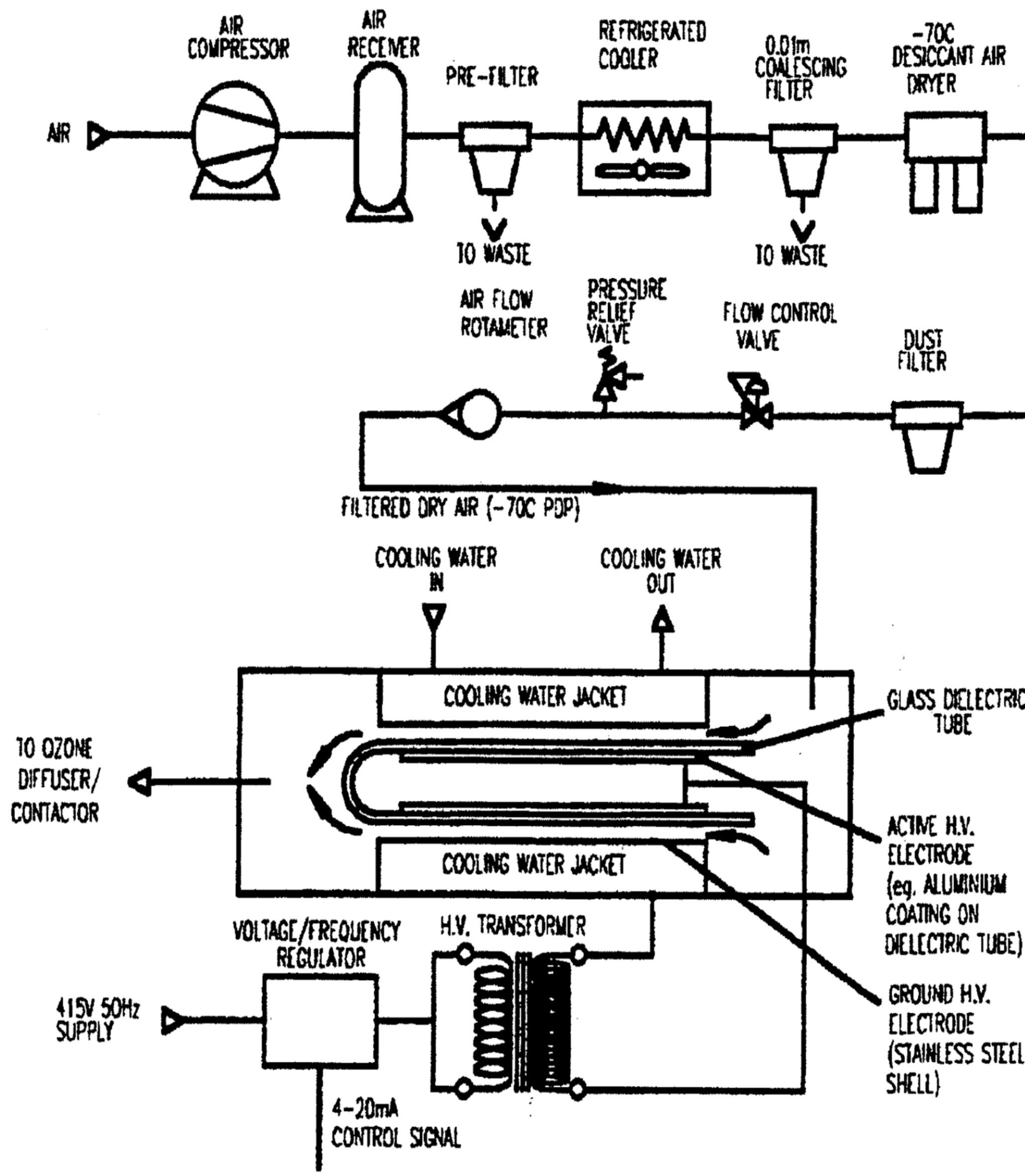

Fig. 2 – Typical Horizontal Tube Ozonator Process Flow Schematic

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Appendix I - Determination of Design Capacity for Public Water Systems

The maximum number of customers that a water system is designed to serve is known as the Customer Design Capacity for that system. The Customer Design Capacity is a calculated value based upon several factors. These factors include, but are not limited to, the following: Well capacity (gallons per minute), service pump capacity (gallons per minute), storage capacity (gallons), distribution system capacity and water treatment capacity (gallons per minute). If a system has exceeded the calculated Customer Design Capacity, it is declared by the MSDH/DWS to be "overloaded".

It is important that officials of public water systems know the Customer Design Capacity of the systems they manage. This information is critical in planning for future water system improvements. By comparing the current customer load to the calculated value of Customer Design Capacity, water system officials and their consulting engineers can make intelligent decisions regarding the timing of needed improvements. Clearly, the Customer Design Capacity calculation is a tool which should be utilized by system officials and their consulting engineers to help identify critical needs before the system becomes "overloaded" and customers are adversely affected.

It is a violation of the Mississippi Safe Drinking Water Act and the regulations of the Mississippi State Board of Health for a public water system to serve customers in excess of its design capacity. A public water system that is serving customers in excess of its design capacity is classified as overloaded by the Mississippi State Department of Health. Public water systems, after officially being notified by the MSDH that they are overloaded, are prohibited from adding any additional customers until the overloaded condition is corrected by the construction of appropriate improvements. Public water systems, after receiving notification from the MSDH that they are overloaded, are required to immediately begin planning to make the necessary improvements to eliminate the overloaded condition.

The procedure which is outlined on the following page has been developed to provide officials of public water systems and their consulting engineers a systematic method of determining the Customer Design Capacity. Please remember that this procedure is based primarily on the adequacy of the water source in determining if the public water system is "overloaded." Other factors such as very small water distribution mains or inadequate water storage will also cause a public water system to be overloaded.

If there are questions regarding the use of this standardized procedure to determine Customer Design Capacity or if there are questions concerning other factors that may cause a public water system to be "overloaded," please contact the Mississippi State Department of Health, Bureau of Public Water Supply at 601/576-7518.

STANDARD PROCEDURE FOR DETERMINING CUSTOMER DESIGN CAPACITY OF A PUBLIC WATER SYSTEM

TYPE #1 - Water Systems with wells only Pumping Directly into the Distribution System

$$\text{Design capacity (\# connections)} = \text{well capacity (gpm)} + \frac{\text{elevated storage (gallons)}}{200}$$

NOTE: Design capacity is limited to twice (2x) well capacity(gpm) unless excess elevated storage is usable (See Note 5 below). Water systems with wells pumping into pressure tanks will have a design capacity equal to the total well capacity (gpm).

TYPE #2 - Water Systems with Clear Wells

Step #1 - Determine the limiting factor(lessor of): well capacity (gpm) ______, treatment capacity (gpm) ______, service pump capacity (gpm) ____

Limiting factor = _______

NOTE: If service pump capacity is limiting factor, skip to step # 3.
[In this situation, usable service pump capacity = service pump capacity]

Step #2 - Determine usable service pump capacity (gpm)

$$\text{usable service pump capacity (gpm)} = \text{limiting factor } \_\_\_\_\_\_\_\_ + \frac{\text{clearwell volume (gallons)}}{200}$$

usable service pump capacity (gpm) = __________ gpm

Step #3 - Determine Customer Design Capacity (CDC)

$$\text{CDC} = \text{useable service pump capacity (gpm) } \_\_\_\_\_\_\_ + \frac{\text{elevated storage (gallons) (see Note \# 5 below)}}{200}$$

Customer Design Capacity (maximum # connections) = __________

TYPE #3 - Water Systems where the MSDH does not have Water Well Capacity (gpm) Information

Well Casing Size	Design Capacity (meters)	Design Capacity (no meters)
2 inch	1 connection	1 connection
4 inch	29 connections	13 connections

NOTE: Above design capacity (# connections) is based on a normal capacity of 50 gpm for 4 inch casing and 15 gpm for 2 inch casing wells (MSDH residential water demand curve is used). If well capacity is documented, this value should be used in conjunction with MSDH residential water demand curve.

DESIGN NOTES:

Note 1: Water systems with standpipes can use top 25 feet as elevated storage

Note 2: Customers served by booster station(s) are not included in the total customers served by the water system unless any water system well(s) must pump more than 12 hours per day.

Note 3: Run time for public water system wells is limited to 12 hours per day.

Note 4: Clear Wells and booster stations must be refilled in 6 hours or less.

Note 5: For excess elevated storage to count as useable, the water system must be capable of refilling elevated tank in 6 (six) hours (based on MSDH approved hydraulic calculations).

Name of Public Water System: ____ PWS ID #: ________________

Capacity Determined by: ____ Date: ______/______/_______

Name (Please Print or Type)

If there are questions regarding this procedure, please contact the Bureau of Public Water Supply at 601/576-7518.

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Appendix J - Notes