

UFGS-44 42 13.00 20 (January 2007)

- 2.6.7 Special Requirements for Circular Plant with Concentric Inner Tank
- 2.7 AERATION EQUIPMENT
 - 2.7.1 General
 - 2.7.2 Diffused Air Aeration Equipment
 - 2.7.2.1 Air Diffusers
 - 2.7.2.2 Diffuser Holder Assembly
 - 2.7.2.3 Air Diffusers in Aerobic Digester
 - 2.7.2.4 Air Blower Assembly
 - 2.7.2.5 Piping
 - 2.7.3 Mechanical Aeration Equipment
 - 2.7.3.1 Drive Assembly
 - 2.7.3.2 Impeller Shaft
 - 2.7.3.3 Impeller
 - 2.7.3.4 Shroud
 - 2.7.3.5 Draft Tube
 - 2.7.3.6 Mechanical Aerator Supports, Walkways and Rails
- 2.8 SLUDGE AND SCUM COLLECTION AND TRANSFER EQUIPMENT
 - 2.8.1 General
 - 2.8.2 Sludge Transfer Pumps
 - 2.8.3 Mechanical Sludge Collection Equipment
 - 2.8.3.1 Chain-and-Flight Type Sludge Collector
 - 2.8.3.2 Traveling Reciprocating Type Sludge Collector
 - 2.8.3.3 Rotating Type Sludge Collectors
- 2.9 ACCESSORIES
 - 2.9.1 Scale
 - 2.9.2 Chlorine Gas Manifold
 - 2.9.3 Flexible Connector
 - 2.9.4 Water Piping
 - 2.9.5 Solution Piping
 - 2.9.6 Vent Tubing
 - 2.9.7 Signal Tubing
 - 2.9.8 Diffuser
 - 2.9.9 Housing
- 2.10 PIPING
 - 2.10.1 Piping Systems
 - 2.10.1.1 Air Piping
 - 2.10.1.2 Sludge Return, Waste Sludge and Scum Return Piping
 - 2.10.1.3 Froth Control System Piping
 - 2.10.1.4 Miscellaneous Piping
 - 2.10.2 Piping System Materials
 - 2.10.2.1 Steel Piping
 - 2.10.2.2 Cast Iron Piping
 - 2.10.2.3 Valves
 - 2.10.2.4 Flexible Sleeve-Type Mechanical Couplings
 - 2.10.2.5 Hangers and Supports
- 2.11 FLOW MEASURING EQUIPMENT
 - 2.11.1 V-Notch Weir
 - 2.11.2 Flow Meter
 - 2.11.2.1 In-Stream Float
 - 2.11.2.2 Float and Cable
 - 2.11.2.3 [Transmitting] Recorder
 - 2.11.2.4 [Transmitting] Recorder-Totalizer-Indicator
 - 2.11.2.5 Charts for Recorder
- 2.12 ELECTRICAL CONTROL SYSTEM COMPONENTS
 - 2.12.1 General
 - 2.12.2 Sequence of Operation
 - 2.12.3 Electrical Control System Enclosure
 - 2.12.4 Circuit Breakers

- 2.12.4.1 Main Circuit Breaker
- 2.12.4.2 Branch Circuit Breakers
- 2.12.5 Starters, Contactors, and Reset Buttons
- 2.12.6 Selector Switches, Pushbuttons, and Pilot Lights
- 2.12.7 Circuit Controls
- 2.12.8 Alarm
- 2.12.9 Electrical Wiring
- 2.13 APPURTENANCES AND ACCESSORIES
 - 2.13.1 Walkways, Platforms, and Bridges
 - 2.13.2 [Access Stairway] [Access Ladder]
 - 2.13.3 Handrails
 - 2.13.4 Raw Sewage Recirculation Box
 - 2.13.5 Plant Influent Flow Division Box
 - 2.13.6 Aeration Tank Influent Distribution Channel
 - 2.13.7 Sludge Division Box
 - 2.13.8 Settling Tank Effluent Weir and Scum Baffle
 - 2.13.9 Mixer for Return Sludge Mixing
 - 2.13.9.1 General
 - 2.13.9.2 Drive Assembly
 - 2.13.9.3 Impeller and Impeller Shaft Coupling
 - 2.13.10 Anchor and Connection Bolts
 - 2.13.11 Plant Anchorage
- 2.14 UTILITIES SERVICE CONNECTIONS
 - 2.14.1 Water Service
 - 2.14.2 Electrical Service
- 2.15 CATHODIC PROTECTION
- 2.16 TREATMENT AND PAINTING
- 2.17 ELECTRICAL REQUIREMENTS
- 2.18 SOURCE QUALITY CONTROL
 - 2.18.1 Mechanical Aerator
 - 2.18.2 Fine Bubble Diffusers
 - 2.18.2.1 Porous Ceramic Tube Diffusers
 - 2.18.2.2 Porous Plastic Tube Diffuser Tests
 - 2.18.3 Coarse Bubble Diffusers
 - 2.18.3.1 Non-porous Nozzle Diffuser Tests
 - 2.18.4 Air Blower Tests
 - 2.18.5 Operation Tests for Electrical Control Panel

PART 3 EXECUTION

- 3.1 DESIGN
- 3.2 SLUDGE COLLECTION AND TRANSFER SYSTEM [AND RETURN SLUDGE MIXING]
 - 3.2.1 Sludge Transfer
 - 3.2.2 Return Sludge Mixing
 - 3.2.3 Scum Collection and Transfer
 - 3.2.3.1 Scum Collection in Hopper Bottom Settling Tanks
 - 3.2.3.2 Scum Collection in Circular Settling Tanks
 - 3.2.3.3 Scum Collection in Rectangular Settling Tanks
 - 3.2.3.4 Scum Transfer
 - 3.2.4 Supernatant Transfer
- 3.3 AIR BLOWER ASSEMBLY
 - 3.3.1 Air Blower
 - 3.3.1.1 Bearing
 - 3.3.1.2 Couplings for Centrifugal Blowers
 - 3.3.2 Blower Driver
 - 3.3.3 V-belt Drive for Positive Displacement Type Blower
 - 3.3.4 Air Blower and Blower Driver Housing
 - 3.3.5 Air Blower Accessories
 - 3.3.5.1 Air Filter and Air Filter Gage

- 3.3.5.2 Butterfly Valve
- 3.3.5.3 Pressure Relief and Unloading Valve
- 3.3.5.4 Check Valve
- 3.3.5.5 Snubber
- 3.3.5.6 Expansion Joints
- 3.3.5.7 Pressure Gage
- 3.3.5.8 Thermometer
- 3.3.5.9 Guards
- 3.4 FROTH CONTROL SYSTEM
 - 3.4.1 General
 - 3.4.2 Froth Control System Pump
 - 3.4.2.1 Submersible Pump
 - 3.4.2.2 Centrifugal Pump
 - 3.4.3 Spray Nozzles
 - 3.4.4 Discharge Strainer
 - 3.4.5 Piping and Valves
- 3.5 HYPOCHLORINATOR ASSEMBLY
 - 3.5.1 General
 - 3.5.2 Hypochlorinator
 - 3.5.2.1 Diaphragm Type
 - 3.5.2.2 Peristaltic Type
 - 3.5.2.3 Motor
 - 3.5.3 Accessories
- 3.6 CHLORINATOR ASSEMBLY
 - 3.6.1 General
 - 3.6.2 Chlorinator
- 3.7 COMMINUTOR AND BAR SCREEN UNIT
 - 3.7.1 General
 - 3.7.2 Comminutor
 - 3.7.2.1 Comminutor Drive
 - 3.7.2.2 Cutting Elements
 - 3.7.2.3 Bearings
 - 3.7.2.4 Lubrication
 - 3.7.2.5 Anchorage
 - 3.7.3 Bar Screen
 - 3.7.4 Comminutor Chamber
- 3.8 SCREENING BASKET
- 3.9 INSTALLATION
 - 3.9.1 General
 - 3.9.2 Manufacturer's Representative
 - 3.9.3 Sequence of Operations
 - 3.9.4 Matchmarking
 - 3.9.5 Qualification of Welders
 - 3.9.6 Piping
 - 3.9.7 Settling Tank Floor
 - 3.9.8 Repair Painting
 - 3.9.9 Adjustments
- 3.10 FIELD TESTS AND INSPECTIONS
 - 3.10.1 General
 - 3.10.2 Alignment and Leveling
 - 3.10.3 Plant Equipment
 - 3.10.3.1 Comminutor Tests
 - 3.10.3.2 Mechanical Aerator Tests
 - 3.10.3.3 Blower-Driven Assembly Operation Tests
 - 3.10.3.4 Diffusers
 - 3.10.3.5 Hypochlorinator Tests
 - 3.10.3.6 Chlorinator Tests
 - 3.10.3.7 Air Lift Pump
 - 3.10.3.8 Flow Measuring Equipment

- 3.10.3.9 Electrical Control System Tests
- 3.10.4 Operating Instructions
- 3.10.5 Plant Start-Up
- 3.11 WORK INCLUDED UNDER OTHER SECTIONS
- 3.12 DELIVERY AND STORAGE

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEA / NASA UFGS-44 42 13.00 20 (November 2009)

Preparing Activity: NAVFAC Superseding
 UFGS-44 42 13.00 20 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2010

SECTION 44 42 13.00 20

AERATION EQUIPMENT 11/09

NOTE: This guide specification covers the requirements for package sewage treatment plants of the extended aeration type, step aeration type, and complete mixing type.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of Technical Proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

NOTE: These plants are intended for treatment of domestic sewage only. Special consideration must be given to sewage containing industrial wastes. This specification is prepared from an uncoordinated draft dated June 1975 and was generally current as of that date. The specifier is warned to use this specification with caution and to confirm all applicable publications and any requirements thought to be questionable. Also, Section 11336, "Rectangular Chain-and-Flight Clarifier" and Section 11337, "Rectangular Reciprocating Traveling-Bridge Clarifier" should be consulted for more up-to-date requirements for all drives and for specific components of mechanical sludge collection.

NOTE: On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA SBRB (Unknown) Ball and Roller Bearings and Ball

AMERICAN GAS ASSOCIATION (AGA)

AGA GMC Gas Measurement Committee Report No. 3

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908 (1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth

ANSI/AGMA 2001 (2004D) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth

ANSI/AGMA 2004 (2008C) Gear Materials, Heat Treatment and Processing Manual

ANSI/AGMA 2009 (2001B) Bevel Gear Classification, Tolerances, and Inspection Methods

ANSI/AGMA 2011 (1998A) Cylindrical Wormgearing Tolerance and Inspection Methods

ANSI/AGMA 6013 (2006A) Standard for Industrial Enclosed

Gear Drives

ANSI/AGMA 6034 (1992B; R 1999) Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors

ANSI/AGMA 6113 (2006A) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

ANSI/AISC 360 (2005) Specification for Structural Steel Buildings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084 (2005) Standard Methods for the Examination of Water and Wastewater

AWWA C111/A21.11 (2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C207 (2007) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.

AWWA C504 (2006) Standard for Rubber-Seated Butterfly Valves

AWWA C600 (2005) Installation of Ductile-Iron Water Mains and Their Appurtenances

AWWA D100 (2005; Errata 2007) Welded Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2010) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B15.1 (2000; R 2008) Safety Standard for Mechanical Power Transmission Apparatus

ASME B16.1 (2005) Gray Iron Threaded Fittings; Classes 25, 125 and 250

ASME B16.4 (2006) Standard for Gray Iron Threaded Fittings; Classes 125 and 250

ASME B16.5 (2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B17.1 (1967; R 2008) Keys and Keyseats

ASME B17.2 (1967; R 2008) Woodruff Keys and Keyseats

ASME B18.2.2 (1987; R 2005) Standard for Square and Hex Nuts

ASME B18.5.2.1M	(2006) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2005) Metric Round Head Square Neck Bolts
ASME PTC 9	(1970; R 1997) Displacement Compressors, Vacuum Pumps and Blowers (for historical reference only)

ASTM INTERNATIONAL (ASTM)

ASTM A 108	(2007) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 176	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 276	(2008a) Standard Specification for Stainless Steel Bars and Shapes
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 320/A 320M	(2008) Standard Specification for Alloy/Steel and Stainless Steel Bolting Materials for Low-Temperature Service
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 395/A 395M	(1999; R 2009) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 47/A 47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

Welded and Seamless

ASTM A 536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B 221	(2008) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 221M	(2007) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B 584	(2009a) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B 62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM B 88M	(2005) Standard Specification for Seamless Copper Water Tube (Metric)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-70	(2006) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(1999) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2005a) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2009) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; TIA 08-1) National Electrical Code
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REDWOOD INSPECTION SERVICE (RIS) OF THE CALIFORNIA REDWOOD
ASSOCIATION (CRA)

RIS Grade Use (1998) Redwood Lumber Grades and Uses

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 10.01 (1982; E 2004) Hot-Applied Coal Tar Enamel
Painting System

SSPC PS 4.02 (1982; E 2004) Four-Coat Vinyl Painting
System (For Fresh Water, Chemical, and
Corrosive Atmospheres)

SSPC Paint 16 (2006) Coal Tar Epoxy-Polyamide Black (or
Dark Red) Paint

SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-24635 (2009; Rev E) Coating Systems, Weather
Resistant, Exterior Use

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-3120 (Basic; Notice 2) Paint: For Swimming Pools

FS TT-E-1593 (Rev B) Enamel, Silicone Alkyd Copolymer,
Gloss (For Exterior and Interior Use)

FS TT-P-645 (Rev B) Primer, Paint, Zinc-Molybdate,
Alkyd Type

U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)

NAVFAC P-355 (1992) Seismic Design for Buildings

1.2 SUBMITTALS

NOTE: Review submittal description (SD) definitions
in Section 01 33 00 SUBMITTAL PROCEDURES and edit
the following list to reflect only the submittals
required for the project. Submittals should be kept
to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the
submittal requires Government approval. Some
submittals are already marked with a "G". Only
delete an existing "G" if the submittal item is not
complex and can be reviewed through the Contractor's
Quality Control system. Only add a "G" if the
submittal is sufficiently important or complex in
context of the project.

For submittals requiring Government approval on Army
projects, a code of up to three characters within
the submittal tags may be used following the "G"

designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete reference to mechanical aerator when step aeration type or complete mixing type is specified, or when not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

NOTE: Delete reference either to chlorinator or to hypochlorinator. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable.

Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

Sewage treatment plant layout

Sewage treatment plant component

Diffuser layout

Mechanical aerator drawings

SD-03 Product Data

NOTE: Delete reference to mechanical aerator when step aeration type or complete mixing type is specified, or when not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete reference either to chlorinator or hypochlorinator. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

Air blower

Air diffusers

[Mechanical aerator]

Spray nozzles

Pump

[Comminutor]

Mechanical sludge collection equipment

Scum collection and transfer equipment

[Chlorinator]

Electrical control system components

Program timer

Air blower accessories

Flow meter

[Hypochlorinator]

SD-06 Test Reports

Sewage treatment plant performance test reports

Package sewage treatment test reports

Mechanical aerator oxygenation capacity tests

Mixing test for mechanical aerator

Oxygen absorption for porous ceramic tube diffusers

Physical properties tests for porous

Permeability for porous ceramic tube diffusers

Oxygen absorption for porous plastic tube diffusers

Permeability for porous plastic tube diffusers

Oxygen absorption for non-porous nozzle diffusers

Air blower tests

Operation tests for electrical control panel

Tank tests

[Comminutor tests]

[Mechanical aerator tests]

Blower-driven assembly operation tests

Oxygenation capacity tests for diffusers

Mixing tests for diffusers

[Chlorinator tests]

Discharge capacity test for air lift pump

Flow measuring equipment calibration

Electrical control system tests

[Hypochlorinator tests]

SD-07 Certificates

List of prior installations

Electrical control system

Diffusers

[Mechanical aerators]

Materials not labeled or certified

SD-08 Manufacturer's Instructions

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete reference either to chlorinator or to hypochlorinator. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

NOTE: Delete "Raw sewage recirculation box" when not required. When sewage is pumped to the treatment plant, the use of a raw sewage recirculation box (which recirculates a portion of incoming sewage back to the pumping station) should be considered to provide uniform flow and avoid

surges through the plant. Decision should be based on undesirability of surge effects on the plant vs. economics of the recirculation system.

NOTE: Delete "Aeration tank influent distribution channel" when not required. Delete this paragraph for extended aeration type except when eventual conversion to step aeration type is contemplated.

NOTE: Delete reference to access ladder when not allowed. Delete references and requirements for access ladder as Contractor's option unless it can be justified on an economic and technical basis. Although more expensive, a stairway is preferable in that it provides safer and easier access to platforms and walkways.

- [Aeration equipment]
- Air blower
- Sludge transfer pumps
- Mechanical sludge collection equipment
- Comminutor
- Froth control system pump
- [Chlorinator]
- Effluent flow measuring equipment
- [Raw sewage recirculation box]
- [Plant influent flow division box]
- [Aeration tank influent distribution channel]
- [Sludge division box]
- Settling tank
- Effluent weir and scum baffle
- Cathodic protection
- Utilities service connections
- Piping
- Electrical wiring
- Excavation and backfilling

Special concrete work

Bridges

Walkways

Access stairway

[Access ladder]

Platforms

Handrails

[Hypochlorinator]

SD-10 Operation and Maintenance Data

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete reference either to chlorinator or to hypochlorinator. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

Aeration system, Data Package 3; G

Sludge collection and transfer system, Data Package 3; G

Air blower assembly, Data Package 3; G

Froth control system, Data Package 3; G

[Comminutor, Data Package 3; G]

[Chlorinator, Data Package 3; G]

[Hypochlorinator, Data Package 3; G]

Submit in accordance with Section 01 78 23 OPERATION AND

MAINTENANCE DATA.

1.3 FACTORY INSPECTION

NOTE: Delete the paragraph when concrete plant only is required. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

Factory inspection shall include soundness of welds and water tightness for tanks fabricated at the factory. The primary and finish shop painting shall be inspected for pin holes or voids.

1.4 TREATMENT AND PAINTING

Except as otherwise specified, equipment shall be treated and painted in accordance with the manufacturer's standard practice. All exposed surfaces of ferrous metals, other than piping, including those to be submerged, shall be sandblasted in accordance with [SSPC SP 6/NACE No.3](#) and shop coated with two coats of epoxy polyamide conforming to [SSPC Paint 16](#) applied to a minimum dry film thickness of [0.20 mm 8 mils](#) per coat. The maximum time between coats shall be 72 hours. The following items shall be finished in accordance with manufacturer's standard practice suitable for end use environment: blowers, motors, gearmotors, motor-driven speed reducers, shafts, [commminutor] [chlorinator] [hypochlorinator] and pushbutton stations. Aluminum shall have an AA-CC-ZZ-A41 finish. Stainless steel, stellite, and nonferrous metals shall not be coated. Exposed surfaces of concrete tanks shall be provided with two coats of rubber-base paint, gloss or semi-gloss, conforming to [CID A-A-3120](#). Blower housing, [chlorinator] [hypochlorinator] housing, and electrical control system enclosure shall be cleaned and sanded. Any external marks or scratches that remain after sanding shall be filled with an epoxy plastic resin and then ground smooth leaving a smooth level surface. All surfaces of housings and enclosures shall be coated with zinc-molybdate primer conforming to [FS TT-P-645](#) and finish coat conforming to [MIL-PRF-24635](#) or [FS TT-E-1593](#), color as directed. All exterior surfaces of piping which is subject to total or intermittent submersion shall be given a vinyl paint system in accordance with [SSPC PS 4.02](#). All exterior surfaces of piping which is not subject to submersion or which are buried shall be given a coal tar coating system in accordance with [SSPC PS 10.01](#).

1.5 QUALITY ASSURANCE

1.5.1 Sewage Treatment Plant Layout Drawings

Show the complete assembly of the plant with all components, equipment, and parts, each with an assigned number corresponding to the plant manufacturer's parts list.

1.5.2 Sewage Treatment Plant Component Drawings

Show construction details for each component and piece of equipment, including aeration tank, settling tank, aerobic digester, chlorine contact tank, blower assembly, diffuser layout, pump assemblies [comminutor assembly] [mechanical aerator assembly] support slab, mechanical sludge collector assembly, [chlorinator assembly] [hypochlorinator assembly] appurtenances, and all piping and wiring.

1.5.3 Diffuser Layout Drawings

Show construction details for the diffuser layout including diffusers, diffuser holders and diffuser holder assemblies blower assembly, and air piping layouts.

1.5.4 Mechanical Aerator Drawings

NOTE: Delete the bracketed phrase when step
aeration type of complete mixing type is specified
or when mechanical aerator is not allowed for
extended aeration type. See Notes A and C located
at rear of text.

Show manufacturer's suggested geometry in sufficient detail for construction. [Show construction details for the mechanical aerator assembly, including shroud and draft tube (if used).]

1.5.5 Excavation and Backfilling

Include specific instructions for excavation and backfilling as interrelated to plant installation and any special concrete work necessary for setting of settling tanks.

1.5.6 List of Prior Installations

Submit a list of installations where plants of similar type as herein specified have been constructed, including the date of construction and capacity of the plant. Certify that the plant furnished and installed is the latest model and that spare parts there for are available.

1.5.7 Sewage Treatment Plant Performance Test Reports

Reports of performance evaluation tests by the National Sanitation Foundation (NSF) are required on the type of plant submitted for this project. These tests shall be carried out in conformance with the criteria based on the use of the Standard Performance Evaluation Method of the NSF report. The test shall be based on the subdivision flow pattern. For all units not tested by NSF, reports of independent performance tests are required on the type of plant submitted for the project. These tests shall

be in accordance with the Standard Performance Evaluation Method based on the subdivision flow pattern as established by the NSF.

1.5.8 Package Sewage Treatment Test Reports

A certified test report by NSF or an independent laboratory for the package sewage treatment plants shall accompany all proposals. This certification shall include a true copy of the tests performed as stated in paragraph entitled "Quality Control," and shall state whether any deviations from the tests required were made. It shall also state what effects, if any, plant size or capacity will have on the results of the plant tested. This certification shall be signed by at least two officials of the organization making the tests.

1.5.9 Tank Tests

NOTE: Delete last sentence when concrete plant only is required. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

Submit a test report stating that (1) the aeration, settling, and aerobic digester tanks of the prefabricated steel plants have been provided watertight, (2) welds are sound, (3) the finish is smooth, and (4) tanks have been shop painted in accordance with the specifications before the tanks are shipped to the site shall be submitted to and approved by the Contracting Officer before work is started.

1.5.10 Electrical Control System

Attest that the electrical control system and its components are wired for motors and controls in accordance with specification requirements for manual and automatic operation of sewage treatment plant equipment for proper operation.

1.5.11 Diffusers

Submit certification that the diffuser layout has an oxygenation capacity of 1.36 kg 3.0 lb for fine bubble diffuser and 0.68 kg 1.5 lb for coarse bubble diffuser of oxygen per electrical input watt per hour horsepower per hour, when tested under standard conditions in cleartap water at 20 degrees C 68 degrees F, zero dissolved oxygen (D.O.) 3 m 10 feet liquid submergence and flow rates of 0.6 L/s 1.25 cubic feet per minute for fine bubble and

3.78 L/s 8.0 cfm for coarse bubble diffusers. Certification shall include description of test procedure, test data, and calculations of oxygenated capacity. Data shall also be furnished to substantiate that the manufacturer's diffuser layout can achieve mixing and adequate velocities for the geometry of the basins.

1.5.12 Mechanical Aerators

NOTE: Delete paragraph when step aeration type or complete mixing type is specified or when mechanical aerator is not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

Submit certification that the aerator has an oxygenation capacity of 1.36 kg 3.0 lb of oxygen per electrical input watt per hour horsepower per hour, when tested under standard conditions in clear tap water at 20 degrees C 68 degrees F and zero D.O. Certification shall include description of test procedure, test data, and calculations of oxygenated capacity. Data shall also be furnished to substantiate that the manufacturer's aerator can achieve mixing and adequate velocities for the geometry of the basin as indicated.

1.5.13 Materials Not Labeled or Certified

For materials whose compliance with organizational standards or specifications is not regulated by an organization using their own listings or labels as proof of compliance, submit a certificate [to the Contracting Officer] stating that the material complies with the applicable referenced standard or specification. This statement shall be in addition to any proof required.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.2 SEWAGE TREATMENT PLANT

NOTE: Delete references to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: When steel plant only is required, delete second and third optional wordings in third sentence. When concrete plant only is required, delete first and second optional wordings in third sentence. When steel plant and concrete plant are both allowed, retain all optional wordings.

This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

The sewage treatment plant (STP) shall include [comminutor] aeration tank, settling tank, chlorine contact tank, aerobic digester, aeration equipment, and other related facilities. Duplicate plants of equal size having a combined capacity equal to the average design flow specified are acceptable. The plant shall be basically of [steel construction, either prefabricated or field-erected] [; or shall be of] [concrete construction, either precast or cast-in-place]. It shall be complete and self-sufficient except for electric power, water supply, and chlorination agent.

2.3 CONCRETE WORK

NOTE: When steel plant only is required, delete second and third optional wordings in third sentence. When concrete plant only is required, delete first and second optional wordings in third sentence. When steel plant and concrete plant are both allowed, retain all optional wordings.

This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior

walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

NOTE: The applicable requirements for cast-in-place concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 03 45 33 PRECAST [PRESTRESSED] STRUCTURAL CONCRETE should be incorporated into the appropriate section of the project specification.

NOTE: Insert appropriate Section numbers and titles in blanks below using format per UFC 1-300-02, "Unified Facilities Guide Specifications (Ufgs) Format Standard".

Concrete work includes [concrete plant walls, partitions, and bottom;] [support slab for all-steel plant or concrete bottom for steel wall plant;] and concrete pad for equipment support. Cast-in-place concrete shall be in accordance with [_____] and [_____]. Precast concrete shall be in accordance with [_____] and [_____]. Results of Government-made soil bearing tests will be furnished to the Contractor.

2.4 LUBRICATION

All moving parts of equipment requiring lubrication shall have means provided for such lubrication and shall be lubricated prior to delivery.

2.5 MATERIALS AND EQUIPMENT

2.5.1 General

NOTE: Delete reference to mechanical aerator when step aeration type or complete mixing type is specified, or when not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

NOTE: Delete reference to mechanical sludge collection equipment for extended aeration type below 0.66 L/s 15,000 GPD capacity. For plants below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for settling tanks. For plants

above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in settling tanks. For plants between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option. However, of the various types of mechanical sludge collectors, rotating sludge collectors appear to be available for plants of 1.31 L/s 30,000 GPD and above; chain-and-flight, 1.75 L/s 40,000 GPD and above; traveling reciprocating type, 0.66 L/s 15,000 GPD and above.

NOTE: Delete "(if used)" for extended aeration type of 4.38 L/s 100,000 GPD capacity and above; for step aeration type 3.0 L/s 67,500 GPD capacity and above; and all complete mixing type plants.

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete reference either to chlorinator or to hypochlorinator. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

NOTE: Delete last sentence when concrete plant only is required. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete

plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

Unless otherwise specified, all materials and equipment shall be new and be standard commercial products in regular production by the manufacturer, and suitable for the required service. The sewage treatment plant shall include the following systems and components: A diffused air aeration system [or mechanical aerator(s)] for the aeration tank and the aerobic digester; [mechanical sludge collection equipment [(if used)] for the settling tank]; froth control system for the aeration tank; sludge pumps in the settling tank and the aerobic digester for sludge transfer; scum removal system for the settling tank; [a comminutor at the plant inlet;] a [chlorinator] [hypochlorinator] and all necessary piping. All structural steel shall conform to **ASTM A 36/A 36M**. All submerged steel members shall have minimum thickness of **6 mm 1/4 inch**. [Reinforced concrete slab shall be designed and constructed for all-steel treatment plant].

2.6 TANKS

2.6.1 General

NOTE: Use appropriate wording depending on whether plant is to be installed above ground (hydrostatic pressures...liquid level) or below ground (soil pressures...operating level).

The following factors should be considered in determining whether plant will be aboveground (at finished grade) or below ground (below finished grade):

1. Gravity flow to plant is to be preferred; need for pumping sewage to plant should be avoided.
2. Elevation should be such as to avoid flooding from surface runoff.
3. Plant should be not less than **900 mm 3 feet** above water table.
4. Plant should be installed below ground in cold locations to prevent freezing; however, concrete plant offers somewhat more protection against freezing than steel.
5. Aesthetic considerations.
6. Extremely aggressive soil conditions.
7. Initial cost savings resulting from aboveground installation.
8. Projected relocation of plant.

NOTE: Delete references to and requirements for seismic loading when unnecessary to consider seismic loading.

On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants **1.09 L/s** **25,000 GPD** or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in **4.38 to 6.57 L/s** **100,000 to 150,000 GPD** range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than **113.4 L** **30 gallons** is needed.
19. Size of hypochlorite solution tank if larger

capacity than 208 L 55 gallons is needed.

20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

Plant shall include aeration tank, settling tank, aerobic digester tank, and chlorine contact tank. Tanks may be separate or contiguous with a common partition between. Plant structure and separate tank structures shall be designed to withstand [hydrostatic pressures [and seismic loading] when installed above grade and filled to normal operating liquid level] [soil pressures (as indicated by Government-furnished soil borings) when installed below grade, backfilled, and dewatered] [; and seismic loading when installed below grade, backfilled, and filled to normal liquid operating level]. [The seismic design shall be based on a load of 133 percent of the combination of the weight of the plant filled to normal operating liquid level plus the seismic loading for Seismic Zone [_____]. Forces from seismic loading shall be determined in accordance with NAVFAC P-355. The basic formula $V = ZKCW$ shall be used where $K = 2.0$, $C = 0.1$, and W is the weight of the tank plus its effective content. Values of Z for each zone are from Table 1-4-1 of NAVFAC P-355.] The plant and support slab shall have sufficient mass to overcome flotation forces when the entire plant is dewatered. Provisions shall be made for dewatering of individual tanks or compartments and entire plant. Shear gates shall be provided for closure of submerged openings in tank partitions.

2.6.2 Aeration Tank

NOTE: Aeration tanks shall have a freeboard of not less than 300 mm one foot for plants 0.88 L/s 20,000 GPD capacity and below, and not less than 450 mm one foot 6 inches for plants of more than 0.88 L/s 20,000 GPD capacity when diffused air is used. Aeration tanks shall have a freeboard of not less than 750 mm 2 feet 6 inches for plants 4.38 L/s 100,000 GPD capacity and below and not less than 900 mm 3 feet for plants of more than 4.38 L/s 100,000 GPD capacity when mechanical aeration is used.

NOTE: Delete freeboard requirement for mechanical aerator use when step aeration type or complete mixing type is specified, or when mechanical aerator is not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

Aeration tank shall have a freeboard of not less than [_____] when diffused

air is used [or not less than [_____] when mechanical aeration is used]. Interior configuration of the aeration tank shall be such as to provide thorough mixing and efficient air dispersion, preclude short-circuiting of the liquid flow, and inhibit solids deposition; baffles shall be provided where necessary to achieve this performance. A stilling baffle shall be provided in the aeration tank before the outlet into the settling tank.

2.6.3 Settling Tank

NOTE: Delete the first and fourth sentences for extended aeration type plants above 4.38 L/s 100,000 GPD capacity, step aeration type plants above 3.0 L/s 67,500 GPD capacity, and for all complete mixing type plants.

NOTE: Delete reference to mechanical sludge collection equipment for extended aeration type below 0.66 L/s 15,000 GPD capacity. For plants below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for settling tanks. For plants above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in settling tanks. For plants between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option. However, of the various types of mechanical sludge collectors, rotating sludge collectors appear to be available for plants of 1.31 L/s 30,000 GPD and above; chain-and-flight, 1.75 L/s 40,000 GPD and above; traveling reciprocating type, 0.66 L/s 15,000 GPD and above.

NOTE: Settling tanks shall have a freeboard of not less than 300 mm one foot for plants of 0.88 L/s 20,000 GPD capacity and below, and not less than 450 mm one foot 6 inches for plants of more than 0.88 L/s 20,000 GPD capacity.

NOTE: In all plants (except circular plants with concrete inner settling tank) where the design flow exceeds 4.38 L/s 100,000 GPD, the settling tank should be in multiple units each capable of independent operation and whose combined capacity equals the design flow rate. In fourth sentence, delete first and third optional wordings when design flow is 4.38 L/s 100,000 GPD and below; delete second optional wording when design flow exceeds 4.38 L/s 100,000 GPD.

NOTE: Delete the first and fourth sentences for extended aeration type plants above 4.38 L/s 100,000 GPD capacity, step aeration type plants above 3.0 L/s 67,500 GPD capacity, and for all complete mixing type plants.

[Settling tank shall have a hopper bottom [when mechanical sludge collection equipment is not provided]]. The settling tank shall have a freeboard of not less than [_____]. The settling tank [, except in circular plants with concentric inner tank,] shall be [in a single unit or] in multiple units [each of which is capable of independent operation and] whose combined capacity equals the design flow. [Hopper bottom of the settling tank shall have slide slopes of not less than 1.05 rad 60 degrees from the horizontal; horizontal area of hopper bottom shall be commensurate with capability of sludge pump for efficient sludge withdrawal]. A stilling well, baffle or other approved means of velocity control shall be provided at the settling tank inlet. Scum baffle or other suitable means shall be provided to prevent scum from passing out with settling tank effluent.

2.6.4 Aerobic Digester

The aerobic digester shall be rectangular, circular or annular segment shape. This tank shall be provided with a compartment so placed as to produce supernatant. When supernatant return is by hydraulic displacement, the supernatant transfer port or pipe connection to the aeration tank shall have its invert elevation or overflow level at not less than 75 mm 3 inches above the design liquid level in the aeration tank. An inlet pipe connection or sludge weir shall be provided for transfer of sludge from the settling tank to the aerobic digester. Pipe connection(s) shall be provided in this tank for waste sludge draw-off. This tank shall have a freeboard of not less than [_____].

2.6.5 Chlorine Contact Tank

Chlorine contact tank shall be rectangular, circular, or annular segment and shall have all necessary rim angles and anchor plates. Tank may be an integral part of the plant or an adjacent detached tank. A 50 mm 2 inch drain with plug shall be provided in tank bottom for flushing and draining sediment from the tank. Bottom of tank shall slope to the drain. Tank shall have a freeboard of not less than 450 mm 18 inches. The tank shall contain not less than three internal baffles which shall be positioned so as to provide thorough mixing within the tank. A flange conforming to AWWA C207, Class B, 200 mm 8 inch size minimum, shall be on the outlet of the tank.

2.6.6 Structural Requirements for Steel Tanks

NOTE: The paragraph when concrete plant only is required. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs

may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger

capacity than 113.4 L 30 gallons is needed.

19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.

20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

Tanks shall be suitable for support by and anchorage to a concrete base. Steel tools shall be in accordance with the applicable requirements of AWWA D100 for shop fabrication and welding of AWWA D100. All shop welding shall be done by a qualified welder. Steel tank walls and bottom shall be structural steel plate. All structural steel shapes used for reinforcing and bracing shall be 6 mm 1/4 inch in the thinnest section. Placement of reinforcing and bracing shall not adversely affect performance characteristics with aeration tank. All welded steel structural members shall be joined by electric arc welding with fillets of adequate section for the joint involved. All sides, compartment partitions, tank bottoms, braces, and corners shall be continuously welded inside and out and ground smooth before priming. Water tightness shall be provided by means of welding. Common partitions shall be reinforced to withstand pressures resulting from liquid level differentials which would occur when any individual compartment(s) is dewatered while contiguous compartments remain at normal operating liquid level.

2.6.7 Special Requirements for Circular Plant with Concentric Inner Tank

NOTE: Delete the paragraph for plants of less than 1.31 L/s 30,000 GPD. This plant configuration appears to be available only above this capacity.

NOTE: Delete optional wording in eighth sentence when steel plant only is required. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

The annular zone between the inner and outer walls shall be the aeration chamber and the aerobic digester zone, and may also have a chlorine contact

zone. The inner circular tank shall be the settling tank. The aeration zone shall have an influent distribution channel (influent launder) for the uniform distribution of the raw sewage. The settling tank shall have an effluent launder for the uniform collection of the clarified liquid from the settling tank. The aeration tank influent distribution channel shall be located on the inside face of the outer tank or outside face of the inner tank and not less than one-half the length of the periphery. The effluent launder shall be located completely around the inner face of the settling tank wall. The inner side of the effluent launder shall be higher than the outer (weir) side to act as a scum baffle. The influent and effluent launders shall be constructed of steel [, except that for concrete-wall settling tank, launders may be of concrete in lieu of steel.] Weir loadings shall not exceed 0.44 L/s per 300 mm 10,000 GPD per linear foot. Weir and scum baffles shall be as specified under paragraph entitled "Appurtenances and Accessories."

2.7 AERATION EQUIPMENT

2.7.1 General

NOTE: Delete reference to mechanical aerator when step aeration type or complete mixing type is specified, or when not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

The aeration system shall be of the diffused air type [or fixed mechanical aeration type] capable of transferring not less than 0.45 kg 1.0 lb of oxygen to the mixed liquor per pound of 5-day BOD aeration tank loading and maintaining complete suspension of all sludge solids throughout the entire aeration tank. The aeration equipment shall completely mix the contents of the aeration tank so that the velocity in any part of the tank shall be not less than 0.18 m/s 0.6 fps. The aerator shall have sufficient mixing capacity to thoroughly mix the wastewater throughout the tank depth, to maintain essentially equal D.O. concentration within the basin, and to maintain the biological floc in suspension in concentrations of up to 4,000 mg/l. Minimum acceptable velocity throughout the basin is 0.18 m/s 0.6 fps.

2.7.2 Diffused Air Aeration Equipment

NOTE: Delete reference to coarse bubble type when not allowed for the plant. For plants of 2.19 L/s 50,000 GPD capacity and below, fine bubble diffusers or coarse bubble diffusers should be allowed as Contractor's option. For plants of more than 2.19 L/s 50,000 GPD, fine bubble diffusers only should be used.

Aeration equipment shall include diffusers, diffuser holder assembly, air blower assembly, piping and accessory items as specified hereinafter. Diffusers shall be of the fine bubble type [or the coarse bubble type]. The oxygen transfer capacity of the diffuser system shall be capable of furnishing an adequate supply of oxygen in the aeration tank to meet treatment requirements at the design sewage load. Air flow shall be from 0.00071 to 0.0014 cubic meter per second 1 1/2 to 3 cubic feet per minute (CFM) at 150 mm 6 inch spacing from each diffuser, giving a minimum air velocity of 12.2 meters per second 40 feet per second through 13 mm 1/2 inch diameter orifice or 0.0008 cubic meter per second 1 3/4 CFM which will give a minimum air velocity of 18.3 meters per second 60 feet per second through 6 mm 1/4 inch diameter diffuser orifice.

2.7.2.1 Air Diffusers

NOTE: Delete reference to coarse bubble type when not allowed for the plant. For plants of 2.19 L/s 50,000 GPD capacity and below, fine bubble diffusers or coarse bubble diffusers should be allowed as Contractor's option. For plants of more than 2.19 L/s 50,000 GPD, fine bubble diffusers only should be used.

The diffuser layout shall have sufficient mixing capacity to thoroughly mix the waste water throughout the tank depth and to maintain the biological floc in suspension in concentrations of up to 4,000 mg/l. Diffusers shall be [fine bubble] [coarse bubble] type.

- a. Fine Bubble Diffusion: Oxygen absorption rating of diffuser tubes shall be not less than 53.0 ppm per hour. Permeability rating of the diffuser tubes furnished under this contract shall be within the following limits:

	<u>Mean Permeability</u>	<u>Minimum</u>	<u>Maximum</u>
Porous Ceramic Tube Diffusers	26	23.4	28.8
Porous Plastic Tube Diffusers	40	36.0	44.0

Fine bubble diffusers shall be porous ceramic tube type or porous plastic tube type.

(1) Porous Ceramic Tube Diffuser: The tube shall be free from any ingredients or processes of manufacture which will cause leaching, clogging, or disintegration when the tube is continuously immersed in, and supplying compressed air to, sewage or sludge. Tube shall be of crystalline aluminum oxide grains, bonded with high alumina glass. Tube shall be kiln-burned at a high temperature. Tube shall withstand sudden changes in temperature which may be experienced during installation and normal operation without cracking or spalling. The individual grains shall be thoroughly bonded together to form a strong, uniformly porous, and homogeneous structure; the tube shall be free of loose or unbonded material. The bond material shall have

a coefficient of thermal expansion similar to the grain coefficient so that the structure will remain thoroughly united in cooling. Grain size shall be uniform. Each diffuser tube assembly shall have one connector assembly with 19 mm 3/4 inch male ANSI standard pipe thread, 10 mm 3/8 inch diameter stainless steel rods and hexagonal nuts with ring gasket, two gaskets suitable for making a tight joint between the metal and the tubes, one bronze bushed air flow controller or orifice, one cap to receive the hexagonal nuts, and one ceramic diffuser tube. All gaskets shall be of a composition suitable for withstanding the action of sewage. The connector assembly and cap shall be of baked epoxy-coated cast iron or stainless steel.

(2) Porous Plastic Tube Diffuser: Tube shall have a body formed by a U-shaped steel rod which is firmly attached to a threaded adapter and fabric holder, all elements being completely coated with vinyl plastic; or tube shall have a body formed by a plastic inner core and adapter. A tubular flexible synthetic cloth sheath, closed at one end and open at the other, shall be fitted around the body and clamped at the open end by a stainless steel clamp to form the diffusion media. Tube devices shall be thread mounted on the diffuser header as recommended by the diffuser manufacturer. Tube shall have an integral control orifice. The adapter and fabric holder shall be of cast iron.

- b. Coarse Bubble Diffuser: Coarse bubble diffusers shall be of the non-porous nozzle type. Nozzle devices shall be saddle-mounted or thread-mounted on a diffuser header as recommended by the diffuser manufacturer. Nozzle orifice shall be sized for the particular application to assure proper range of exit velocity and back pressure. Diffuser parts shall be stainless steel, zinc-coated steel, molded plastic, or chloroprene. They shall be corrosion resisting, impact resistant, self-cleaning and non-absorbent. The diffuser unit shall be provided with an adapter fitting stud for attaching to the air header where necessary. They shall contain an anti-backflow device of polyvinyl chloride or neoprene. Header-diffuser system shall be able to accommodate a wide range of air flows by varying the orifice opening automatically, or be selection of orifice size of installation.

2.7.2.2 Diffuser Holder Assembly

NOTE: Delete reference to swing-out type when steel plant only is required. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete

(except that all-steel would be needed for relocatable plants).

The diffuser holder assembly shall be of the fixed type [or swing-out type].

- a. Fixed Type Diffuser Holder Assembly: The assembly shall include an air control and shut-off valve and all air piping downstream from this valve. Valve shall be of the butterfly valve, plug valve, or globe valve type and be suitable for air control with indicator markings for throttling and complete shut-off. Butterfly valve shall conform to AWWA C504, and globe valve shall conform to MSS SP-80, shall have cast-iron body and chloroprene rubber seat, and shall be lever or handwheel operated. Spacing of diffuser assemblies in the basin shall be such as to provide air diffuser nozzles mounted approximately 150 mm 6 inches on centers. The drop-pipes shall be provided with union or equivalent connection adjacent to the air header to permit raising the drop-pipe above the water surface readily. The drilling and tapping of the horizontal portion of drop-pipes shall be such as to give the diffuser correct horizontal alignment without being skewed either upward or downward.

NOTE: Delete the paragraph when steel plant only is required. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

- b. Swing-out Type Diffuser Holder Assembly: The assembly shall include an upper pivot joint with air control and shut-off valve and a drop-pipe with intermediate pivot joint, and a diffuser header. The upper pivot joint shall be of cast iron or cast steel and shall have a trunnion type support for the rotary joint. The unit shall have a base flange for mounting to a wall anchorage elbow, and the joint shall rotate on two bronze sleeve bearings either permanently lubricated or with suitable grease fittings for lubrication. Chloroprene or Buna N rubber O-ring gaskets shall be included at each pivot bearing to insure air and water tightness. Valve shall be butterfly type and be suitable for air control with indicator markings for throttling and complete shut-off. Butterfly valve shall conform to AWWA C504, shall have a cast-iron or bronze body and chloroprene rubber seat, and shall be lever or handwheel operated. Means shall be provided for shut-off of air supply when diffuser holder assembly is in raised position. The intermediate pivot joint shall be as specified for the upper joint,

except that it shall not have the integral valve and base flange. Threaded or flanged connections shall be provided for the upper and lower hanger pipes. Bearings with O-ring seals shall be as specified for the upper pivot joint. The intermediate pivot joint shall have a locking device to allow positive locking in any position. Spacing of diffuser assemblies in the tank and diffusers on the header shall be as recommended by the diffuser manufacturer. The drilling and tapping of the horizontal portion of drop pipe shall be such as to give the diffuser the correct horizontal alignment without being skewed either upwards or downwards. Horizontal portion of drop pipe shall incorporate an adjustable stop on the wall side to prevent the diffuser from coming on contact with the wall. A portable hoist shall be provided to raise and lower the diffuser assembly. Hoist shall be expressly designed to be compatible with the diffuser holder assembly and shall be provided by the same manufacturer. Hoist shall be engine- or motor-driven hydraulically operated, pneumatically operated or manual, with quick clamping arrangement to securely engage upper hanger pipe. The hoist shall be adequately powered to raise the assembly from a dry tank. The hoist shall provide means of locking the diffuser header in a raised position over the tank or the walkway.

2.7.2.3 Air Diffusers in Aerobic Digester

Drop-pipe with air diffusers shall be provided in the tank with placement of diffusers near the bottom. Air control valve shall be of the needle valve or globe valve type and shall have indicator markings for throttling and complete shut-off; globe valve shall conform to MSS SP-80. The amount of air supplied to the tank shall be sufficient to allow aerobic stabilization of solids and in no case less than 0.25 cubic meter per second of air per 1,000 cubic meters 15 CFM of air per 1,000 cubic feet of tank volume.

2.7.2.4 Air Blower Assembly

Air blower assembly shall be as specified in paragraph entitled "Air Blower Assembly."

2.7.2.5 Piping

Piping shall include piping from air blower assembly to aeration tank and aerobic digester, air header piping and drop piping (piping from air header to diffusers). Materials for piping and gate and plug valves shall be as specified in paragraph entitled "Piping."

2.7.3 Mechanical Aeration Equipment

NOTE: Delete paragraph and subparagraph thereto when step aeration type or complete mixing type is specified, or when mechanical aerator is not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is

contemplated.

The **mechanical aerator** shall be of the fixed type and shall include a drive assembly, impeller shaft, impeller, and shroud, and may include a draft tube. All accessories necessary for proper operation and to provide necessary required oxygenation capacity, including flow straightening surge rings or tank baffles, shall be provided.

2.7.3.1 Drive Assembly

Drive assembly shall include an electric motor, gear reduction unit, bearings, and shall be fully enclosed for outdoor installation.

NOTE: Insert electrical power characteristics.

- a. Motor: Motor shall be constant speed, totally enclosed, fan-cooled, horizontal type, with solid shaft, suitable for outdoor service, and conforming to **NEMA MG 1**. The motor shall be of adequate **wattage horsepower** to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [____] volt, [____] phase, [____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. Vertical motor shall be directly connected to the gear reduction unit or else connected by a flexible coupling. Horizontal motor shall be connected to the gear reduction unit by a flexible coupling only. In lieu of a constant speed motor with a gear reduction unit, a two-speed motor may be provided as a means of speed reduction.
- b. Gear Reduction Unit: The 2-speed gear reduction unit shall be of the vertical gear motor type or the horizontal speed reducer type. The minimum AGMA service factor when the unit is operating at full load motor **wattage horsepower**, 24 hours a day continuous running under moderate shock loads, shall be 1.5 for speed reducers and 2.0 for gear motors. It shall have a life expectancy of 100,000 hours with the probability of no more than 10 percent failures prior to its expected life. The unit shall be designed to withstand any loading produced by thrust, out-of-balance, and vibration resulting from operating conditions. All components shall be designed to withstand continuously the full load motor **wattage horsepower** for the life expectancy specified, including motor starting torques up to 250 percent of motor running torques. Gearing may be spur, helical, spiral bevel, or a combination thereof. If helical, the helical angle shall not exceed **0.314 rad 18 degrees**. Worm gearing will not be acceptable. All gears shall be AGMA Quality 10 or higher as outlined in **ANSI/AGMA 2009** or **ANSI/AGMA 2011**. All gears shall be inspected in accordance with the best accepted practice and shall be certified as to meeting the specified quality. In establishing the capacity of the unit to transmit power, the following AGMA standards for surface durability, strength and materials shall govern: Spur gearing and helical gearing: **AGMA 908, ANSI/AGMA 2001, ANSI/AGMA 2004, ANSI/AGMA 6113 ANSI/AGMA 6013, and ANSI/AGMA 6034**
- c. All gears shall be wrought or alloy steel. The gear teeth may be through-hardened, contour-induction hardened, nitrided, or carburized.

Flame-hardened gears will not be acceptable. The housing shall be of high-quality, close-grained cast iron. A lubrication system shall be provided for the gears. Bath lubrication systems requiring oil seals for containment or lubrication systems which rely upon an oil circulating pump shall include a proven reliable means to stop the drive motor in the event of insufficient lubrication. Pressure indicating devices influenced by oil sludge and changes in oil viscosity will not be acceptable. Bearings may be lubricated with oil or grease.

- d. Bearings shall have a minimum rated life expectancy (L-10) of 100,000 hours based on [ABMA SBRB](#) Standards when operating continuously at the rated full-load motor [wattage horsepower](#) and speed under the specified loading conditions. Internal bearings may be either oil or grease lubricated. All grease lubrication pressure lines shall be fed from fittings accessibly located above the platform supporting the mechanism. Underwater bearings will not be acceptable.
- e. Base plate or mounting lugs shall be either constructed of steel or shall be integrally cast with the gear reduction unit and shall be furnished with not less than three leveling anchor bolts with lock nuts.

2.7.3.2 Impeller Shaft

The shaft shall be of sufficient diameter to withstand the loading imposed by the impeller, using a safety factor of 1.5. The shaft shall be removable from the speed reducer by means of a bolted coupling. The shaft shall be of solid steel construction conforming to [ASTM A 108](#) or steel pipe conforming to [ASTM A 53/A 53M](#).

2.7.3.3 Impeller

The impeller shall be of fabricated structural steel, Type 304, stainless steel, or of glass fiber reinforced polyester plastic laminate. The aeration blades shall be designed to achieve the maximum aeration and pumping effect. The impeller shall be bolted to the impeller shaft with Type 316 stainless steel bolts and shall be readily removable from the shaft.

2.7.3.4 Shroud

The aerator shall be equipped with a shroud designed to prevent the mixed liquor from splashing and spraying the underside of the supporting platform, walkway, railings, and walls of the aeration tank. The shape of the shroud shall be circular and extend beyond the diameter of the impeller. The shroud shall either be attached to the impeller and rotate with it or be mounted in a stationary position above it supported from the platform. The shroud may be in more than one section and shall permit easy removal from the aerator. If the shroud rotates with the impeller, it shall be dynamically and statically balanced to prevent any out-of-balance loading on the driving unit. The size, shape and location of the shroud shall not reduce the required certified oxygenation capacity of the aerator. The aerator with shroud in place shall operate without excessive spraying. The shroud shall prevent splashing at the selected speed and at any submergence of the impeller within the specified operating liquid levels of the aeration tank. Shroud shall have adequate cross-section to provide stiffness and rigidity to withstand the wave pumping action of the aerator. Shroud material shall be steel or fiberglass. The use of wood will not be permitted. All bolts and fastenings shall be of Type 316

stainless steel.

2.7.3.5 Draft Tube

Draft tube, where a part of the manufacturer's design, shall be fabricated from 5 mm 3/16 inch minimum thickness steel plate, reinforced and stiffened with structural steel sections, supported by legs, and anchored to the bottom of the tank. It shall be designed to create a pump action by the impeller on the liquid at the bottom of the tank to move the liquid to the impeller for aeration. The clearance between the draft tube and the bottom of the tank shall be such that activated sludge floc will not be broken. A means of height adjustment shall be provided.

2.7.3.6 Mechanical Aerator Supports, Walkways and Rails

Supports for mechanical aerator mounting plate shall be placed on bottom of tank or extended from structural steel beams on tank walls. Service walkway to mechanical aerator shall be provided and shall have handrails on each side.

2.8 SLUDGE AND SCUM COLLECTION AND TRANSFER EQUIPMENT

2.8.1 General

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NOTE: For plants below 0.66 L/s 15,000 GPD
capacity, hopper bottom only should be specified for
settling tanks. For plants above 4.38 L/s 100,000
GPD capacity, mechanical sludge collectors only
should be used in settling tanks. For plants between
0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD
capacity, either hopper bottom or mechanical sludge
collector should be allowed as a Contractor's
option. However, of the various types of mechanical
sludge collectors, rotating sludge collectors appear
to be available for plants of 1.31 L/s 30,000 GPD
and above; chain-and-flight, 1.75 L/s 40,000 GPD and
above; traveling reciprocating type, 0.66 L/s 15,000
GPD and above.
*****

*****
NOTE: Delete reference to mechanical sludge
collection equipment for extended aeration type below
0.66 L/s 15,000 GPD capacity.
*****

*****
NOTE: Delete "(if used)" for extended aeration type
of 4.38 L/s 100,000 GPD capacity and above; for step
aeration type 3.0 L/s 67,500 GPD capacity and above;
and all complete mixing type plants.
*****

*****
NOTE: Delete last sentence for extended aeration
type below 0.66 L/s 15,000 GPD capacity or above
4.38 L/s 100,000 GPD capacity, for step aeration
type above 3.0 L/s 67,500 GPD capacity and all for
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complete mixing type.

Sludge and scum collection and transfer equipment shall include sludge transfer pump(s), [mechanical sludge collection equipment [(if used)],] scum collection and transfer system, and supernatant transfer. [Settling tanks with hopper bottom and side walls having slope of not less than 1.05 rad 60 degrees with the horizontal need not be provided with mechanical sludge collection equipment].

2.8.2 Sludge Transfer Pumps

Sludge transfer pump(s) shall be an air lift pump. Air lift type pump shall include an air pipe, eductor, foot piece, tail pipe, air separator and a vent pipe. The air pipe to the eductor shall be of zinc-coated steel schedule 40 of adequate size to discharge the required amount of liquid without excessive pressure drop. Sludge transfer pump(s), except separate waste sludge pump, shall have a recirculation capacity ranging from zero percent to not less than 100 percent of the design flow. An air control valve shall be provided on the air pipe to provide accurate adjustment of the air lift discharge rate. Air control valve shall be a needle valve, globe valve, ball valve, or plug valve. Materials for globe, ball, and plug valves shall be as specified in paragraph entitled "Piping." The tail pipe below the foot piece, the eductor pipe, air separator, and vent from it shall be of zinc-coated steel. All fittings shall be of zinc-coated malleable iron or cast iron. Joints between elements shall be as specified in paragraph "Piping." The eductor shall be provided with a clean-out above the water level. Air lift pump shall be installed so as to permit easy removal for maintenance.

2.8.3 Mechanical Sludge Collection Equipment

NOTE: On the drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.

10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

For plants below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for settling tanks. For plants above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in settling tanks. For plants between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option. However, of the various types of mechanical sludge collectors, rotating sludge collectors appear to be available for plants of 1.31 L/s 30,000 GPD and above; chain-and-flight, 1.75 L/s 40,000 GPD and above; traveling reciprocating type, 0.66 L/s 15,000 GPD and above.

NOTE: Delete paragraph and subparagraphs thereto for extended aeration type below 0.66 L/s 15,000 GPD capacity.

NOTE: Delete first sentence when step aeration type is specified or extended aeration type where eventual conversion to step aeration is contemplated.

NOTE: Delete reference to chain-and-flight type
when complete mixing type is specified, or for
extended aeration type plants of less than 1.76 L/s
40,000 GPD capacity.

NOTE: Delete second sentence for plants below 1.31
L/s 30,000 GPD capacity.

[Rectangular settling tanks shall have [chain-and-flight type or] traveling reciprocating type sludge collectors]. [Circular tanks shall have rotating type sludge collectors.] All settling tank walls with slopes less than 1.05 rad 60 degrees with the horizontal shall be scraped by the sludge collector.

2.8.3.1 Chain-and-Flight Type Sludge Collector

NOTE: Delete paragraph and subparagraphs thereto
when step aeration type or complete mixing type is
specified, or for extended aeration type of less than
1.76 L/s 40,000 GPD capacity or extended aeration
type where eventual conversion to step aeration is
contemplated.

On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or

belowground construction.

12. Seismic loading (if necessary).

13. Electric power characteristics for motors.

14. Whether automatic operation of air lift pumps should be required.

15. Wind load and ice load for rotating sludge collector.

16. Organic loading (5-day BOD) if other than that given in the text.

17. Total suspended solids if other than given in the text.

18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.

19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.

20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

For plants below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for settling tanks. For plants above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in settling tanks. For plants between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option. However, of the various types of mechanical sludge collectors, rotating sludge collectors appear to be available for plants of 1.31 L/s 30,000 GPD and above; chain-and-flight, 1.75 L/s 40,000 GPD and above; traveling reciprocating type, 0.66 L/s 15,000 GPD and above.

The equipment shall be chain-and-flight type, designed to move settled sludge to a sludge hopper. The equipment shall include a drive assembly and a sludge collector assembly.

- a. Design: The sludge collector assembly shall operate at a linear speed between 10 and 15 mm per second 2 and 3 fpm. The mechanism and its component parts shall be designed, with a minimum factor of safety of 4, to withstand all structural and mechanical stresses brought about by the drive assembly and the following loadings: dead load and a sludge load equal to a horizontal load of 117 N per meter 8 lbs per linear foot of scraper blade in a scraping position. The mechanism shall be designed for continuous 24-hour service under design load without excessive wear, damage, or failure. The mechanism shall be capable of operating in a dry tank without overloading the equipment. Stresses developed under the aforementioned operating conditions and loads shall

not exceed the allowable stresses conforming to ANSI/AISC 360.

- b. Drive Assembly: Drive assembly shall include motor; speed reducer; drive sprocket on output shaft of speed reducer, drive chain from drive sprocket to driven sprocket, shera pin, and chain guard. Unit shall be fully enclosed and designed for mounting outside and exposed to the weather.

- (1) Motor: Motor shall be constant speed, totally enclosed, horizontal type, suitable for outdoor service, and conforming to NEMA MG 1. The motor shall be of adequate wattage horsepower to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [____] volt, [____] phase, [____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. Motor shall be directly connected to the speed reducer through a flexible coupling.
- (2) Speed reducer shall be either a helical gear reduction unit or a worm gear reduction unit fully enclosed in a cast iron or fabricated steel case provided with dust and oil seals with all gears running in oil and with anti-friction bearings throughout. Gears used in speed reducer shall conform to applicable requirements of the following Standards. Speed reducer shall be designed with a minimum AGMA service factor of 2.0 and shall also have an AGMA Service Classification II.

Helical gearing: AGMA 908, ANSI/AGMA 2001, ANSI/AGMA 2004, ANSI/AGMA 6034, ASTM A 48/A 48M, ASTM A 536,

Worm gearing: ANSI/AGMA 6113 ANSI/AGMA 6013, ANSI/AGMA 6034, ASTM A 536

- (3) Bearings incorporated within the drive assembly shall be of the antifriction type and conform to the following minimum schedule of rated-life expectancy (L-10) based on the ABMA SBRB Standards when operating at the normal continuous torque rating of the mechanism:

Worm gearbox bearings: L10-100,000 hours

Geared motor (direct drive): L10-100,000 hours

Intermediate helical gearbox bearings: L10- 17,000 hours

Geared motor (indirect drive): L10- 17,000 hours

Speed reducer case shall be equipped with oil fill port, oil drain line, and an oil level indicator pipe.

- (4) Chain and Belt Drives: Drive transmission within and from the drive assembly shall be by chain and/or belt. Chain and belt drives incorporated in the drive assembly shall be designed with a minimum factor of safety of 4 as applied to the ultimate breaking of transmission strength of the chain or belt with respect to the loads transmitted at normal continuous operating load. Chain and sprocket or V-belt and pulleys connecting motor and speed reducer shall be enclosed in a weatherproofed fabricated steel or fiberglass guard. Chain connecting motor and speed reducer shall

be steel roller type. Sprockets shall be hardened ground alloy steel or high-test cast-iron, having a minimum tensile strength of 276 MPa 40,000 psi cast in a chill, and shall have Brinell hardness of not less than 360 with a chill depth of not less than 5 mm 3/16 inch. Sprocket teeth shall be accurately ground to fit the chain. V-belts shall be rayon corded with heat and oil resisting rubber covering. Motor position of V-belt drives shall be adjustable to increase or decrease belt tension. The drive sprocket shall be keyed on the output shaft of the speed reducer and shall be bronze bushed with a grease-lubricated bronze bushing and provided with shear pin overload protection. The drive chain shall be of the steel roller type, shall weigh not less than 1.36 kg per 300 mm 3.0 pounds per foot, and shall have an average ultimate tensile strength of 110 MPa 16,000 pounds. The drive chain shall have a minimum pitch of 65 mm 2.6 inches. A drive chain tightener shall be provided to adjust and tighten the chain.

- c. Sludge Collector Assembly: Assembly includes collector chain, driven sprocket, idler sprockets, shafts, bearings, collector flight and collector return rail.
- (1) Collector chain shall have an average ultimate strength of 96.5 MPa 14,000 pounds. Chain links shall be of corrosion resisting malleable iron having average tensile strength of 517 MPa 75,000 psi and an average Brinell hardness between 170 and 190. Attachments for scrapers shall be full depth of scraper and attached with four bolts. Coupling pins shall be not less than 19 mm 3/4 inch diameter heat treated high carbon steel. All cotter pins shall be stainless steel. Pivoted attachments shall be provided for at least two scrapers on each collector, so designed as to assure positive cleaning of tank corners. All special links shall be of the same material as the main chain links.
 - (2) Sprockets shall be high-test cast-iron, having a minimum tensile strength of 138 MPa 20,000 psi cast in a chill and shall have a Brinell hardness of not less than 360 with a chill depth of at least 5 mm 3/16 inch. Sprockets shall be stress relieved before machining. Sprocket teeth shall be accurately ground to fit chain. Sprockets shall be split construction assembled with cadmium plated nuts and bolts. Driven sprocket on the headshaft shall be of the offset type. The three sprockets on the head shaft shall be key seated. The idler and chain take-up shaft sprockets shall not be key seated but, except for number of teeth, shall be identical in other respects to the head shaft sprockets. On each idler and take-up shaft, one sprocket shall be set-screwed and one sprocket shall turn free between two set-screwed collars.
 - (3) Shafting shall be solid, cold-finished steel, ASTM A 108, straight and continuous for full width of tank. Shafting shall be of sufficient size to transmit the maximum force developed by the drive assembly. Keyways shall be provided where necessary to attach or locate sprockets on shafting. Keys and key seats shall conform to ASME B17.1 or ASME B17.2. Shafting shall be polished in areas of contact with bearings.
 - (4) Bearings shall be babbit-lined, sleeve type, self-aligning ball-and-socket type or heat treated ductile iron, self-aligning type. All bearings, except those for bracket-supported driven sprockets, shall be bolted to the tank walls. Bearings shall be

designed to allow minimum field variations without shimming. Bracket supports, except on head shaft driven sprocket, will not be allowed. Bearings above water shall be provided with flush ball-check grease-lubrication fittings. Underwater bearings shall be water lubricated with tops designed to prevent solids accumulation. Underwater bearings shall have flush ball-check grease-lubrication fittings for use during initial operation and at times when the tank is dewatered. Take-up bearings shall be provided on take-up shaft. Take-up bearings shall be self-aligning, shall be arranged to slide between or to be steadied by two cast-iron, mild steel or silicon bronze guides. Take-up bearings shall have a minimum range of travel of 250 mm 10 inches and shall be positioned by a stainless steel or silicon bronze threaded power bolt which shall be arranged for locking at any position of the bearing. All bearings shall be rated for a minimum of 5 years' continuous service condition.

- (5) Collector Flights: Collector flights shall be made of Select Heart California Redwood graded in accordance with RIS Grade Use. Flights shall be 50 mm by 150 mm 2 inches by 6 inches and shall extend the full width of the tank with 13 mm 1/2 inch clearance at each end. Flights shall be spaced at approximately 2.75 to 3 m 9 to 10 foot intervals and shall operate at a linear speed between 10 to 15 mm per second 2 to 3 fpm.

Wearing shoes shall be provided on each flight to run on tee rails on the tank bottom. Wearing shoes shall be fabricated of 10 mm 3/8 inch thick steel angles, case hardened to a minimum Brinell hardness of 555. Wearing shoes shall be as wide as the flight thickness and 25 mm one inch longer than the width of the bottom rail. Flights shall be accurately drilled and notched at the factory and shall be carefully grouped and fastened together for shipment.

- (6) Rails and Tracks: Two industrial type steel rails, minimum weight of 7.26 kg per 900 mm 16 pounds per yard each, shall be provided for each collector mechanism. All necessary splice bars, rail clips, and appurtenances shall be included. Return tracks shall be structural steel shapes having a minimum thickness of 10 mm 3/8 inch and shall be supported by steel cross members supported from compartment walls.

2.8.3.2 Traveling Reciprocating Type Sludge Collector

**NOTE: Delete paragraph and subparagraphs thereto
when step aeration type is specified or extended
aeration type where eventual conversion to step
aeration is contemplated.**

The equipment shall be traveling reciprocating type designed either to move settled sludge to a sludge hopper or to continuously collect settled sludge by means of an airlift pump integral with the sludge collector assembly. The equipment shall include motor drive assembly, collector drive assembly, and collector assembly.

- a. Design: The sludge collector assembly shall operate at a linear speed of 5 to 20 mm per second 1 to 4 fpm. The mechanism and its component

parts shall be designed, with a minimum factor of safety of 4, to withstand all structural and mechanical stresses brought about by the drive assembly and the following loadings: dead load and maximum anticipated sludge load. The mechanism shall be designed for continuous 24-hour service under design load without excessive wear, damage, or failure. The mechanism shall be capable of operating in a dry chamber without overloading the equipment. Stresses developed under the aforementioned operating conditions and loads shall not exceed the allowable stresses conforming to ANSI/AISC 360.

- b. Motor Drive Assembly: Motor drive assembly shall include a motor speed reducer, drive sprocket on output shaft of speed reducer, drive chain from drive sprocket to driven sprocket, shear pin, and chain guard. Unit shall be fully enclosed and designed for mounting outside and exposed to the weather.

NOTE: Insert electrical power characteristics. On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.

16. Organic loading (5-day BOD) if other than that given in the text.

17. Total suspended solids if other than given in the text.

18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.

19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.

20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

(1) Motor: Motor shall be constant speed, totally enclosed, horizontal type, suitable for outdoor service, and conforming to NEMA MG 1. The motor shall be of adequate wattage horsepower to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [_____] volt, [_____] phase, [_____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. Motor shall be directly connected to the speed reducer through a flexible coupling.

(2) Speed Reducer: Speed reducer shall be either a helical gear reduction unit or a worm gear reduction unit fully enclosed in a cast iron or fabricated steel case provided with dust and oil seals with all gears running in oil and with anti-friction bearings throughout. Drive motor shall be close-coupled to or on the input shaft of the gear reduction unit, except that roller chain drives or V-belt drives may be used between the drive motor and the gear reduction unit. Gears used in speed reducer shall conform to applicable requirements of the following AGMA Standards. Speed reducer shall be designed with a minimum AGMA service factor of 2.0 and shall also have an AGMA Service Classification II.

Spur gearing and helical gearing: AGMA 908, ANSI/AGMA 2001, ANSI/AGMA 2004, ANSI/AGMA 6113 ANSI/AGMA 6013 ANSI/AGMA 6034, ASTM A 48/A 48M, ASTM A 536,

Worm gearing: ANSI/AGMA 6113 ANSI/AGMA 6013, ANSI/AGMA 6034, ASTM A 536

(3) Bearings: Bearings incorporated within the drive assembly shall be of the antifriction type and conform to the following minimum schedule of rated-life expectancy (L10) based on the ABMA SBRB Standards when operating at the normal continuous torque rating of the mechanism:

Worm gearbox bearings: L10-100,000 hours

Geared motor (direct drive): L10-100,000 hours

Intermediate helical gearbox bearings: L10- 17,000 hours

Geared motor (indirect drive): L10- 17,000 hours

Speed reducer case shall be equipped with oil fill port, oil drain line, and an oil level indicator pipe.

- (4) Chain and Belt Drives: Drive transmission within and from the drive assembly shall be by chain and/or belt. Chain and belt drives incorporated in the drive assembly shall be designed with a minimum factor of safety of 4 as applied to the ultimate breaking or transmission strength of the chain or belt with respect to the loads transmitted at normal continuous operating load. Chain and sprockets or V-belt and pulleys connecting motor and speed reducer shall be enclosed in a weather-proofed fabricated steel or fiberglass guard. Chain connecting motor and speed reducer shall be steel roller type. Sprockets shall be hardened ground alloy steel or high-test cast-iron, having a minimum tensile strength of 276 MPa 40,000 psi cast in a chill, and shall have Brinell hardness of not less than 360 with a chill depth of not less than 5 mm 3/16 inch. Sprocket teeth shall be accurately ground to fit the chain. V-belts shall be rayon corded with heat and oil resisting rubber covering. Motor position of V-belt drives shall be adjustable to increase or decrease belt tension. The drive sprocket shall be keyed on the output shaft of the speed reducer and shall be bronze bushed with a grease-lubricated bronze bushing and provided with shear pin overload protection. The drive chain shall be of the steel roller type, shall weigh not less than 1.36 kg per 300 mm 3.0 pounds per foot, and shall have an average ultimate tensile strength of 110 MPa 16,000 pounds. The drive chain shall have a minimum pitch of 65 mm 2.6 inches. A drive chain tightener shall be provided to adjust and tighten the chain.
- c. Collector Drive Assembly: Collector drive assembly includes collector drive chain, sprockets, rails or tracks, and supporting structure. Collector mounting to drive assembly shall be provided with counterweight or similar device to counteract leverage exerted by the collector assembly and permit all surfaces to be scraped uniformly.
- (1) Collector Drive Chain: Collector chains shall have an ultimate strength of not less than 96.5 MPa 14,000 pounds each. Chain links shall be of corrosion resisting malleable iron having an average tensile strength of not less than 517 MPa 75,000 psi and a Brinell hardness of 170 to 190. The drive chain shall extend the full length of the run. Means shall be provided for continuous lubrication of the chain. Chain drive shall be covered by a metal guard of No. 15 zinc-coated steel. Coupling pins shall be not less than 13 mm 1/2 inch in diameter heat-treated high carbon steel. All other pins shall be stainless steel. Means for chain adjustment shall be provided.
- (2) Sprockets: Sprockets shall be high-test cast-iron, having a minimum tensile strength of 138 MPa 20,000 psi cast in a chill and shall have a Brinell hardness of not less than 360 with a chill depth of at least 5 mm 3/16 inch. Sprockets shall be stress relieved before machining. Sprocket teeth shall be accurately ground to fit chain. Sprockets shall be split construction assembled with cadmium plated nuts and bolts. Sprockets on the head shaft shall be key seated.

- (3) Tracks or Rails: Monorail type beam or supporting track for the guidance of the collector assembly shall be provided. The track may be in the form of an up-turned channel or otherwise have vertical guides to prevent lateral movement unless the supporting element or carriage has built-in means of preventing lateral movement. Rail or track shall be of sufficient size to support the entire collector mechanism and limit deflection to 1/240 of the span.
- (4) Collector Drive Support: The collector drive shall be rigidly supported by structural steel members of sufficient size. Mounting plates for setting the units in place shall be provided.
- d. Collector Assembly: Collector assembly shall include carriage or supporting element, scrapers and scraper supports and vertical connecting members, and air supply hose (if used). Carriage or supporting element of the collector assembly shall be firmly attached to the collector drive through a suitable connection.
 - (1) Carriage or Supporting Element: Rollers for carriage or supporting element shall be of heat-treated cast-iron, or heat treated wrought steel with a Brinell hardness of 100 to 120. Axles shall be mounted on roller bearing or ball bearing assemblies. Bearings shall have a rated-life expectancy (L-10) of 40,000 hours based on the ABMA SBRB Standards when operating under the normal continuous operating load. Flush ball-check grease fittings shall be provided for all points needing grease lubrication. Where rail or track does not have means of preventing lateral movement such beams shall be incorporated into the carriage or supporting element through horizontal rollers or other suitable method.
 - (2) Scrapers and Scraper Supports: Adjustable scraper blades shall be provided and shall be designed to continuously scrape the surfaces of the settling tank as the collector assembly traverses the length of the tank. The blades shall be of chloroprene rubber. Cross bracing or other suitable members shall be provided to properly support the scraper blades.
 - (3) Vertical connecting member shall be of sufficient size to support the scrapers and scraper supports. Where the traveling reciprocating type collector is designed to continuously collect settled sludge the air lift pump shall be an integral part of the sludge collector assembly and the assembly shall be designed specifically for this purpose. Where air lift discharge piping exerts leverage on the collector assembly, a counterweight shall be provided to keep the entire assembly vertically aligned.
 - (4) Air Supply Hose: Air for air lift shall be supplied by a suitable hose of sufficient length and diameter. Placement of hose shall be such that there will be no interference between the hose and any other element in the tank.

2.8.3.3 Rotating Type Sludge Collectors

**NOTE: Delete paragraph and subparagraphs thereto
for plants below 1.31 L/s 0,000 GPD Capacity. For
plants below 0.66 L/s 5,000 GPD capacity, hopper**

bottom only should be specified for settling tanks. For plants above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in settling tanks. For plants between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option. However, of the various types of mechanical sludge collectors, rotating sludge collectors appear to be available for plants of 1.31 L/s 30,000 GPD and above; chain-and-flight, 1.75 L/s 40,000 GPD and above; traveling reciprocating type, 0.66 L/s 15,000 GPD and above.

The sludge collector shall be bridge supported rotary type designed to move settled sludge to a center sludge hopper. The equipment shall include a drive assembly, a sludge collector assembly supporting bridge, and overload alarm system.

NOTE: Insert required loads. On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps

should be required.

15. Wind load and ice load for rotating sludge collector.

16. Organic loading (5-day BOD) if other than that given in the text.

17. Total suspended solids if other than given in the text.

18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.

19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.

20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

- a. Design: The mechanism shall be designed to have a minimum continuous output torque rating of 2710 joules 2,000 foot pounds and to rotate at a constant speed to produce a peripheral speed of 31 to 51 mm per second 6 to 10 fpm. The rotating mechanism and its component parts shall be designed, with a minimum factor of safety of 4, to withstand all structural and mechanical stresses brought about by the following loadings: continuous output rated torque load, dead load, wind load of [____], [ice load of [____]], and a live load on the access bridge of 2.4 kPa 50 psf. Stresses developed under the aforementioned loads shall not exceed the allowable stresses conforming to ANSI/AISC 360. Deflection of support bridge under maximum load shall not exceed 1/360 of the span.
- b. Drive Assembly: Drive assembly shall include motor, gearing, bearings, main bearing assembly, and chain and belt drives. Drive shall be either a single worm gear reduction unit, a double worm gear reduction unit, or a worm and spur gear reduction unit, driven by an electric motor through a speed reducer or by an electric gearmotor. Drive motor shall be close-coupled to or on the input shaft of the gear reduction unit, except that roller chain drives or V-belt drives may be used between the drive motor and gear reduction unit. V-belt drives will not be permitted directly on the center shaft which rotates the collector assembly. The equipment design shall be such that all gears run in oil and all bearings shall be oil or grease lubricated. Gear cases shall be equipped with oil fill port, oil drain line and an oil level indicator pipe. The design of each drive assembly shall be such as to permit sustained operation at the continuous output torque rating without excessive wear and to develop twice the continuous output torque rating without damage to or failure of the drive assembly components.

NOTE: Insert electrical power characteristics. On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).

2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

- (1) Drive Assembly Motor: Motor shall be constant speed, totally enclosed, horizontal type, suitable for outdoor service, and conforming to NEMA MG 1. The motor shall be of adequate wattage horsepower to drive the equipment continuously at the maximum load

encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [_____] volt, [_____] phase, [_____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. Motor shall be directly connected to the speed reducer through a flexible coupling.

- (2) Gearing: The main gear and worm gear assemblies shall be enclosed in a cast iron or fabricated steel housing provided with felt dust seals. Gear assemblies used in speed reducers or geared motors shall conform to AGMA service classification II. Gears used in the drive assembly shall conform to the applicable requirements of the following standards.

Spur gearing and helical gearing: AGMA 908, ANSI/AGMA 2001, ANSI/AGMA 2004, ANSI/AGMA 6113 ANSI/AGMA 6013, ASTM A 48/A 48M, ASTM A 536

Worm gearing: ASTM A 536

The main internal or external spur gear shall be of high test modular cast iron, heat treated alloy cast steel or heat treated forged steel; pinion shall be of heat treated alloy steel or heat treated forged steel. Worm gear shall be of cast bronze or high-test cast iron; worm shall be hardened ground alloy steel or high-test heat treated cast iron. The main internal or external spur gear shall have an endurance and strength rating of 1,000,000 cycles.

- (3) Bearings: All bearings incorporated within the drive assembly shall be of the anti-friction type and conform to the following minimum schedule of rated-life expectancy (L-10) based on the ABMA SBRB Standards when operating at the normal continuous torque rating of the collector:

Worm and wheel gearbox bearings: L10-100,000 hours

Geared motor (direct drive): L10-100,000 hours

Intermediate helical and spur gearbox bearings: L10- 17,000 hours

Geared motor (in direct-drive): L10- 17,000 hours

- (4) Main Bearing Assembly: The main bearing assembly shall include the arrangement of bearings on which the collector assembly is mounted for support and alignment. The assembly shall be designed for the radial and axial loads imposed by the drive assembly and the sludge collector assembly. Bearings shall run in an oil bath or shall be grease lubricated. The design of the main bearing assembly shall permit the replacement of the balls or rollers, or the steel liners, or the complete bearing unit. Bearing raceway material shall have adequate strength to withstand all radial and axial loads and shall have a minimum Brinell hardness of 250. The assembly may incorporate an additional submerged split-case, water-lubricated bottom guide bearing where manufacturer's design necessitates use of bottom guide bearing.
- (5) Chain and Belt Drives: Chain or belt drives incorporated in the drive assembly shall be designed with a minimum factor of safety

of 5 as applied to the ultimate breaking or transmission strength of the chain or belt with respect to loads transmitted at twice the continuous output torque rating of the unit. Roller chain and sprockets or V-belt and pulleys shall be enclosed in a weatherproof fabricated steel or fiberglass guard provided with service openings. Chains shall be of the steel roller type. Sprockets shall be high test cast-iron conforming to ASTM A 48/A 48M, Class 40, cast in a chill and shall have a Brinell hardness of not less than 360 with a chill depth of not less than 5 mm 3/16 inch. Sprocket teeth shall be accurately ground to fit the chain. V-belts shall be rayon corded with heat and oil resisting rubber covering. Motor position of V-belt drives shall be adjustable to increase or decrease belt tension. The drive sprocket keyed on the output shaft of the speed reducer shall be bronze with a grease-lubricated bronze busing and provided with shear pin overload protection. A chain tightener shall be provided to adjust and tighten the chain.

- c. Sludge Collector Assembly: Assembly shall include scraper arms, scraper blades, and center shaft. Collector assembly shall have scraper blades arranged to move settled sludge to a centrally located sludge hopper.
 - (1) Scraper Arms: Scraper arms shall be of structural steel shapes supported by steel guy wires and/or steel tie rods. Scraper blades shall be steel plate, minimum thickness 6 mm 1/4 inch.
 - (2) Scraper Blades: Scraper blades shall be steel plate, minimum thickness 6 mm 1/4 inch. Brass scrapers, minimum thickness 3 mm 1/8 inch, shall be secured to the scraper blades by brass bolts with brass nuts. Scrapers shall be adjustable for 50 mm 2 inches in the vertical plane. A scraper blade shall also be provided to scrape the sludge hopper.
 - (3) Center Shaft: Center shaft shall be a solid steel shaft or steel pipe conforming to ASTM A 53/A 53M, Schedule 40. Steel pipe shall have solid shaft stub ends or machined flange at the top and steel cap or plug at the bottom. Scraper arms shall be connected to the center shaft by welded and/or bolted connections.
- d. Supporting Bridge: Supporting bridge shall be the bridge spanning the settling tank and supporting the entire rotating type sludge collector. Supporting bridge shall include two structural steel beams and braces of sufficient depth and thickness to support the entire rotating sludge collector within the specified maximum allowable deflection.
- e. Overload Alarm System: Overload alarm system shall be a waterproof torque actuated overload unit or indicating ammeter overload unit designed to indicate the load on the mechanism at all times and to sound an alarm in case of impending excessive load, and to stop the mechanism when such load is reached. The overload alarm shall include an industrial type horn, relay, and reset button in a weatherproof metal housing with a removable gasketed cover. The horn shall be constructed of corrosion-resisting material and shall be suitable for remote mounting. A shutoff switch, NEMA Type 2, shall be provided for the horn.

2.9 ACCESSORIES

2.9.1 Scale

NOTE: Insert "two" for plants of 11 L/s 250,000 GPD
capacity and less; and "three" for plants above 11
L/s 250,000 GPD.

Scale shall be beam indicating floor type portable platform scale with a capacity of not less than 450 kg 1,000 lb. Scale shall include a weigh beam mounted on a metal pillar attached to a frame. The scale shall be provided with four metal wheels. Platform shall be of adequate size to accommodate 68 kg 150-lb cylinders of chlorine.

2.9.2 Chlorine Gas Manifold

Chlorine gas manifold shall be of a material resistant to chlorine and suitable for the working pressure involved.

2.9.3 Flexible Connector

Flexible connector between chlorine gas manifold and the chlorinator shall be extra-heavy Type K seamless copper tube conforming to ASTM B 88M
ASTM B 88.

2.9.4 Water Piping

Water piping shall be schedule 80 PVC piping with solvent welded joints. Gate valve and check valve conforming to MSS SP-80 and a Y-pattern brass or stainless steel strainer shall be provided.

2.9.5 Solution Piping

Solution piping from chlorinator to diffuser shall be flexible polyethylene pipe, chlorine solution hose, rigid polyvinylchloride (PVC) pipe, or rigid acrylonitrile-butadiene-styrene (ABS) pipe.

2.9.6 Vent Tubing

Vent tubing shall be any elastomer or plastic tubing resistant to chlorine or chlorine solutions. Any other material having qualities acceptable for such use may be substituted in place of the elastomer or plastic tubing. Vent line shall be sloped continuously downward to outside of housing without dips or sags. Insect screen shall be provided at end of line.

2.9.7 Signal Tubing

Signal tubing shall be Type K soft copper tubing.

2.9.8 Diffuser

Diffuser shall be of rigid PVC or ABS pipe resistant to chlorine solution. The diffuser shall be perforated and of the open channel type and shall be fastened at each end to the tank wall near the bottom in the flow stream of the influent to the chlorine contact tank.

2.9.9 Housing

The chlorinator scale, piping, and controls shall be enclosed in a weatherproof housing constructed of 0.9 mm 20 gage metal with minimum 25 mm one inch insulation. Full access door shall be provided for easy access to equipment. The housing shall be mounted on top of treatment plant or on a concrete pad adjacent to the chlorine contact tank which shall project not less than 150 mm 6 inches beyond outside face of housing. A thermostatically controlled space heater shall be provided within the housing to maintain a temperature of 21 degrees C 70 degrees F.

2.10 PIPING

2.10.1 Piping Systems

2.10.1.1 Air Piping

Air piping shall include all piping from the blowers to the diffusers and air lift pumps. Air supply piping from blowers to header shall be black steel piping. Primary air header shall be black steel or black steel rectangular section. Drop piping shall be black steel. Feeder piping shall be black steel or aluminum. Air lift pump air supply piping shall be black steel. Gate valves shall be provided in air piping branches from air main when serving two or more air diffuser drop pipes; gate valves shall be provided as blow-off valves for air mains.

2.10.1.2 Sludge Return, Waste Sludge and Scum Return Piping

Piping shall be black steel. Gate valves shall be provided on air lift discharge piping between the air lift discharge riser and the air separator. Gate valves, globe valves, or plug valves shall be provided in branch piping for return sludge and waste sludge lines when separate return sludge and waste sludge pumps are not used. A hose bibb shall be provided in waste sludge piping.

2.10.1.3 Froth Control System Piping

Piping shall be black steel. Gate valves shall be provided in suction and discharge piping to froth control pump and in the froth control main line piping immediately adjacent to the hose bibb branch on the downstream side.

2.10.1.4 Miscellaneous Piping

NOTE: Delete third sentence when steel plant only is required. On the project drawings, show:

- 1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).**
- 2. Design flow.**
- 3. 5-day BOD loading.**
- 4. Suspended solids loading.**
- 5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.**

6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of

steel or concrete (except that all-steel would be needed for relocatable plants).

Inlet piping shall be of steel shall be welded to aeration tank wall of steel plant. It shall have a flanged 862 kPa 125 psi ASME B16.1 connection to incoming sewer line. [Inlet piping for concrete aeration tanks shall be provided in sleeve in wall and connected to incoming sewer by means of a grout ring]. Tank drain or dewatering piping shall be black steel or cast iron. Gate valves or shear gates shall be provided for tank drain or dewatering piping.

2.10.2 Piping System Materials

2.10.2.1 Steel Piping

Steel pipe for sizes 100 mm 4 inch diameter and smaller shall be standard weight zinc-coated steel pipe conforming to ASTM A 53/A 53M, with fittings of cast iron conforming to ASME B16.4, Type II. Steel pipe for sizes 125 mm 5 inch diameter and larger shall be seamless or electric-resistance welded, standard-weight, black steel pipe conforming to ASTM A 53/A 53M, Grade B. Joints for pipes sizes 50 mm 2 inch diameter and smaller shall be screwed joints. Joints for pipe sizes 63 mm 2 1/2 inch through 100 mm 4 inch diameter shall be screwed or flanged. Flanges shall conform to, ASME B16.5, or AWWA C207. Bolts and nuts for flanged connections shall conform to the requirements specified in AWWA C207. Gaskets shall be plain rubber gaskets 3 mm 1/8 inch thick.

2.10.2.2 Cast Iron Piping

Cast iron piping shall be standard commercial grade cast iron pressure pipe and fittings shall be suitable for the purpose.

2.10.2.3 Valves

- a. Gate Valves: Gate valves 50 mm 2 inches and smaller shall have threaded ends and shall conform to MSS SP-80; gate valves 63 mm and 75 mm 2 1/2 and 3 inches in size shall have flanged ends and shall conform to MSS SP-70 or MSS SP-80; gate valves 100 mm 4 inches and larger shall have flanged ends and shall conform to MSS SP-70. Valves shall be rising stem or outside screw and yoke type. Valves for air service and froth control system shall be wedge or double disc type. Valves for sludge service shall be solid wedge type.
- b. Globe Valves: Globe valves shall conform to MSS SP-80.
- c. Plug Valves: Plug valves shall be lubricated, regular pattern type conforming to MSS SP-78 or eccentric plug type conforming to the applicable requirements of MSS SP-78.
- d. Ball Valves: Ball valves shall conform to MSS SP-72.

NOTE: Delete reference to concrete wall in first sentence when steel plant only is required.

- e. Shear Gates: Shear gates shall be flange frame type suitable for bolting to flanged pipe or to partition wall [or for setting in

concrete wall]. Frame and disc or cover shall be of cast iron with bronze seating rings in both frame and disc. Hinge pin shall be bronze. Seating wedge(s) shall be integral with the frame or bolted on. Contact surfaces between frame and disc or cover shall be machine finished. Operation shall be by means of lifting handle with positioning points. Lifting handle shall be of such length as to be accessible from the walkway.

- f. Hose Bibb: Hose bibb shall be of all-brass construction and shall have 19 mm 3/4 inch hose thread.

2.10.2.4 Flexible Sleeve-Type Mechanical Couplings

NOTE: Minimum number of bolts for each pipe size
should be as follows: 75 mm 3 inch, 3; 100 mm 4 inch,
4; 150 mm 6 inch, 5; 200 mm 8 inch.

Couplings shall be provided in flanged piping where necessary to facilitate removal of piping sections or for other use as necessary for manufacturer's design. Couplings shall be designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall be such as to provide for confinement and compression of the gaskets. Middle ring shall be of steel and the follower rings shall be of steel or malleable iron. Malleable iron shall conform to ASTM A 47/A 47M. Steel shall have a strength not less than that of the pipe. Gaskets shall be designed for long life and resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts shall be track-head type; bolts and nuts shall conform to the tensile requirements of ASTM A 307, Grade A; or bolts shall be round-head square-neck type conforming to ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts conforming to ASME B18.2.2. Bolts shall be 16 mm 5/8 inch in diameter; minimum number of bolts for each coupling shall be [_____] for [_____] mm inch pipe [, [_____] for [_____] mm inch pipe,] and [_____] for [_____] mm inch pipe]. Bolt holes in follower rings shall be of a shape to hold fast the necks of the bolts used. Sleeve-type mechanical couplings shall not be used as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint.

2.10.2.5 Hangers and Supports

Hangers and supports shall be of standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions and shall be adjustable split ring type supported by threaded rods hung from beam clamps. Hanger rods shall be machine-threaded, and based on rod diameter. For pipe under 100 mm 4 inches, the rods shall be not less than 13 mm 1/2 inch in diameter; for pipe 100 mm 4 inches and above, not less than 19 mm 3/4 inch in diameter. Pipe saddle supports shall be adjustable type with provision for firm anchorage. Where support is from tank walls, welded steel brackets shall be provided with anchor chair.

2.11 FLOW MEASURING EQUIPMENT

The effluent flow measuring equipment shall be V-notch weir and flowmeter.

2.11.1 V-Notch Weir

The V-notch weir measuring channel for measuring effluent of plant shall be made of 6 mm 1/4 inch steel with a stainless steel or aluminum 1.05 rad 60 degree V-notch weir plate. The notch shall be cut with extreme accuracy and care to maintain sharp upstream edges and exact cross section, the downstream edge shall be beveled. The upstream face of the weir plate shall be flat and smooth; any bolts or rivets used to fasten the plate shall be countersunk flush with the plate. Bolt holes shall include provision for adjustment of height and level. The bottom of the notch shall be approximately 125 mm 5 inches above the floor of the channel and the invert of the channel outlet. The invert of the inlet shall be at the same elevation as the bottom of the V-notch. A 250 mm 10 inch long scale for measuring the water depth upstream of the weir shall be provided and securely fastened in the channel. Scale shall be stainless steel with baked-on enamel. The channel shall be rectangular, and provided with a baffle and 50 mm 2 inch drain and plug. Inlet and outlet connections shall be ASME B16.1 200 mm, 862 kPa 8 inch, 125 lb. A flow chart of the 1.05 rad 60 degree V-notch weir shall be furnished, indicating flow in L/s thousand gallons per day. Capacity of weir and channel shall be not less than capacity of plant at peak flows.

2.11.2 Flow Meter

NOTE: Delete "transmitting" when hypochlorinator is specified. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

NOTE: Delete reference either to recorder or to recorder-totalizer-indicator. A recorder-totalizer-indicator should be specified instead of a recorder when it is necessary to keep records of total flow.

NOTE: Delete last part of first sentence when hypochlorinator is specified.

Flow meter shall include in-stream float or float-and-cable mechanism for differential measurement and a [transmitting] [recorder] [recorder-totalizer-indicator] for local read-out [and for transmission to chlorinator].

2.11.2.1 In-Stream Float

The in-stream float shall have a range of from 5 to 150 percent of the average flow through the plant. The measuring system shall include a float, float rod or stainless steel bead cable, transfer assembly, and cam mechanism designed to transmit the measurement through mechanical linkage or through signal transmission of the impulse duration type of the null-balance inductance-bridge type so as to result in uniformly graduated units of flow. The float shall be of plastic or stainless steel and the float arm shall be of stainless steel. The float shall be provided with stops to prevent overranging and damping, and shall be equipped with a zero adjustment. All materials of construction shall be of standard corrosion-resisting materials. Accuracy shall be plus or minus 2 percent of actual rate over a 5 to one range.

2.11.2.2 Float and Cable

The float and cable shall have a range of from 5 percent to 150 percent of the average flow through the plant. The crest level shall be measured in a stilling well. The measuring system shall include a float, cable, drum, transfer gear assembly and cam mechanism designed to transmit the measurement through mechanical linkage or through signal transmission of the impulse duration type of the null-balance inductance-bridge type so as to result in uniformly graduated units of flow. The float shall be of polyester, polystyrene, stainless steel or copper, and be of suitable weight and shape for the intended purpose. The cable shall be plastic-coated multi-strand stainless steel, stainless steel beads or multi-strand monel. The drum shall be grooved to prevent overlapping of the cable. The float and cable shall be provided with stops to prevent overranging and a zero adjustment. All materials of construction shall be corrosion-resisting materials. Protection tubes for the cables shall be provided. Accuracy shall be plus or minus 2 percent of actual rate over a 5 to one range.

2.11.2.3 [Transmitting] Recorder

NOTE: On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.

9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

NOTE: Delete paragraph when recorder-totalizer indicator is needed. A recorder-totalizer-indicator should be specified instead of a recorder when it is necessary to keep records of total flow.

NOTE: Delete "Transmitting" in heading when hypochlorinator is specified.

NOTE: For recorder charts, use monthly charts for extended aeration type plants 0.88 L/s 20,000 GPD and below and for plants in remote locations. Use weekly charts for extended aeration type and step aeration type above 0.88 L/s 20,000 GPD capacity through 6.60 L/s 150,000 GPD capacity. Use daily charts for extended aeration type and step aeration type above 6.60 L/s 150,000 GPD capacity, and for all complete mixing type plants.

NOTE: Insert electrical power characteristics.

NOTE: Delete requirements for signal transmission to the chlorinator when hypochlorinator is specified.

NOTE: Insert electrical power characteristics.

The [transmitting] recorder shall read in liters per second thousands of gallons per day in uniformly graduated units and shall have a range of from 5 to 150 percent of the average flow through the plant. The chart shall be visible through a shatterproof clear window. Internal movements within the instrument shall in no way interfere with taking of the differential measurement. The mechanism shall not be affected by the intended end use environment. The chart shall be 250 or 300 mm 10 or 12 inches in diameter and shall rotate once [daily] [weekly] [monthly]. The chart shall be driven by a synchronous motor suitable for operation on [_____] volt, [_____] phase, [_____] Hertz service. [The signal transmission to the chlorinator shall be impulse duration type or milliampere direct current analog signal type. All transmission shall be actuated by the output motion of the meter. Power shall be [_____] volt, [_____] Hertz service.] The case shall be aluminum, fiberglass, or painted steel and part of with the meter. The unit shall be weatherproof, equipped with a sealed door for access to the mechanism, and designed to prevent the accumulation of moisture or fog inside the case. A suitable mounting stand shall be provided.

2.11.2.4 [Transmitting] Recorder-Totalizer-Indicator

NOTE: On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.

6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

NOTE: Delete "Transmitting" in heading when hypochlorinator is specified.

NOTE: For recorder charts, use monthly charts for extended aeration type plants 0.88 L/s 20,000 GPD and below and for plants in remote locations. Use weekly charts for extended aeration type and step aeration type above 0.88 L/s 20,000 GPD capacity through 6.60 L/s 150,000 GPD capacity. Use daily charts for extended aeration type and step aeration type above 6.60 L/s 150,000 GPD capacity, and for all complete mixing type plants.

NOTE: Insert electrical power characteristics.

NOTE: Delete requirements for signal transmission to the chlorinator when hypochlorinator is specified.

The [transmitting] recorder-totalizer-indicator shall combine the functions of recording, totalizing indicating within one case; shall read in liters per second thousands of gallons per day in uniformly graduated units; and shall have a range of from 5 to 150 percent of the average flow through the plant. The chart, totalizer read-out, and indicator scale shall be visible through a shatterproof clear window(s). Internal movements within the instrument shall in no way interfere with taking of the differential measurement. The mechanism shall not be affected by the intended end use environment. The chart shall be 250 or 300 mm 10 or 12 inches in diameter and shall rotate once [daily] [weekly] [monthly]. The chart drive shall be driven by a synchronous motor suitable for operation on [_____] volt, [_____] phase, [_____] Hertz service. Totalizer shall read the total flow in thousand liter thousand gallon units using only a whole power of 10 multiplier. [The signal transmission to the chlorinator shall be impulse duration type or milliamper direct current analog signal type. All transmission shall be actuated by the output motion meter. Power shall be [_____] volt, [_____] Hertz service.] The case shall be aluminum, fiberglass, or painted steel and part of the meter. The unit shall be weatherproof equipped with a sealed door for access to the mechanism, and designed to prevent the accumulation of moisture or fog inside the case. A suitable mounting stand shall be provided.

2.11.2.5 Charts for Recorder

One year's supply of charts and ink shall be furnished for recorder.

2.12 ELECTRICAL CONTROL SYSTEM COMPONENTS

2.12.1 General

NOTE: Specify outdoor type enclosure except when enclosure will be located in a building.

NOTE: Insert electrical power characteristics. On

the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

The system shall include enclosure; main and branch circuit breakers; starters, contactors, and reset buttons; selector switches, push buttons, and pilot lights; circuit control items for electrical control of the various plant components; and all necessary wiring and tubing. Electrical control system shall be in accordance with **NEMA ICS 1**. Design, fabrication and installation of all electrical components shall be in accordance with requirements of **NFPA 70**. Electrical controls shall be mounted in [outdoor weatherproof enclosure, NEMA 3R] [indoor enclosure, NEMA 1 OR NEMA 12]. Enclosure shall be divided into compartments. Compartment for time clock and timers shall be separate and isolated from that housing other electrical components, except that lighting circuit breaker may be included therein. Electrical controls shall be wired so that the various items of plant equipment can be operated either manually and/or automatically to achieve the sequence of operation specified hereinafter. All electrical control system components shall be completely wired and mounted in the enclosure at the manufacturer's plant and tested prior to shipment from the factory. The electric service available is [_____] volt, [_____] phase, [_____] Hertz, [_____] wire. All push buttons, selector switches, and indicating lights shall be installed on the outside of the door(s), properly identified with laminated phenolic name plates. All components on outside of enclosure and on internal panels shall be identified by engraved laminated phenolic legend plates.

2.12.2 Sequence of Operation

The electrical control system and its components shall be designed and interconnected as to perform the following automatic functions:

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

- a. The 7-day **program timer** shall automatically start and stop the blowers [comminutor,] and froth control system pump. A percentage timer shall automatically start and stop blower motors.
- b. If operating lead blower should stop, standby blower, acting in response to setting of failure transfer timer, shall automatically start and stay in operation until such time as lead blower returns to service. Range of failure transfer timer shall be such as to prevent the transfer to the standby system from such causes as momentary interruptions of power, loss of power and similar malfunctions. A selector switch shall be provided to allow manual change in the lead-standby system. Pressure switches in the motor control circuit shall be arranged to cause the system failure transfer circuit to operate when there is a lack of or loss of pressure due to belt slippage or breakage, or air loss, until such time as the fault is corrected. Horn and warning light alarm circuits shall be energized to indicate that the standby system has replaced the selected lead blower in operation.

NOTE: Delete first sentence or second sentence in item (c) depending on whether chlorinator or hypochlorinator is specified. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

- c. [Chlorinator shall be controlled by the flow meter and shall start, stop, and proportionally regulate the dosage in response to signals there from]. [Hypochlorinator shall start and stop in response to signals from liquid level sensing probes.]
- d. Thermostat shall automatically place into operation equipment automatically taken out of service by the 7-day timer when the outside air temperature drops below 0 degrees C 32 degrees F or any other predetermined temperature setting.
- e. A percentage timer shall automatically control sludge transfer pump, scum transfer pump, and supernatant return pump.
- f. Froth control system pump shall be suitably interlocked with blowers so as to automatically start and stop in parallel with the blowers.

2.12.3 Electrical Control System Enclosure

NOTE: Specify outdoor type enclosure except when enclosure will be located in a building.

NOTE: Use first optional wording in last sentence for outdoor enclosure and second optional working for indoor enclosure.

Enclosure shall be [a free-standing, floor-mounted type indoor unit] [an outdoor unit with support legs] and shall be constructed of sheet steel. Screened ventilating openings shall be installed in the enclosure. Enclosure shall have rubber-gasketed doors provided with continuous piano hinge and cylinder locking type door latches. Each door shall be equipped with positive locking device. A copy of the external wiring connections and a circuit breaker index print shall be secured to the inside of door. Control panel shall be mounted on legs formed from steel or angle iron welded to the bottom of the enclosure. The legs shall have bottom plates drilled with holes for securing the panel to [tank platform or concrete pad] [concrete floor].

2.12.4 Circuit Breakers

All circuit breakers shall be thermal magnetic type.

2.12.4.1 Main Circuit Breaker

Main circuit breaker shall have a maximum capacity of 150 percent of the electrical load. The main circuit breaker shall be an external handle mechanism mounted outside the enclosure to permit operation of this breaker from outside the enclosure. Main circuit breaker shall be provided with positive locking device to permit locking the operating handle.

2.12.4.2 Branch Circuit Breakers

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete reference to mechanical aerator when step aeration type or complete mixing type is specified, or when not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

NOTE: Delete reference to sludge collector drive motor for extended aeration type below 6.60 L/s 150,000 GPD capacity. For plants below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for settling tanks. For plants above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in settling tanks. For plants between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option. However, of the various types of mechanical sludge collectors, rotating sludge collectors appear to be available for plants of 1.31 L/s 30,000 GPD and above; chain-and-flight, 1.75 L/s 40,000 GPD and above; traveling reciprocating type, 0.66 L/s 15,000 GPD and above.

NOTE: Delete reference to hypochlorinator when chlorinator is specified. Hypochlorinator should be

specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

NOTE: Delete "control circuit transformer" when not needed to step down incoming service voltage.

NOTE: Delete "chlorinator housing heater" or "hypochlorinator housing heating device" in areas where freezing temperatures are not encountered, depending on whether chlorinator or hypochlorinator is specified. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

Branch circuit breakers shall be E-frame bolt-on type mounted on interior bus bar. Branch circuit breakers shall be provided for each blower, [comminutor,] [mechanical aerator(s),] froth control system pump, [sludge collector drive motor (when used),] [hypochlorinator,] control circuit, [control circuit transformer,] flow meter, [chlorinator housing heater,] [hypochlorinator housing heating device,] chart drive motor, lighting circuit(s), and receptacle. Panel shall include spaces for 4 additional circuit breakers.

2.12.5 Starters, Contactors, and Reset Buttons

NOTE: Delete reference to mechanical aerator when step aeration type or complete mixing type is specified, or when not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000

GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete reference to sludge collector drive motor for extended aeration type below 6.60 L/s 150,000 GPD capacity. For plants below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for settling tanks. For plants above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in settling tanks. For plants between 0.66 and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option. However, of the various types of mechanical sludge collectors, rotating sludge collectors appear to be available for plants of 1.31 L/s 30,000 GPD and above; chain-and-flight, 1.75 L/s 40,000 GPD and above; traveling reciprocating type, 0.66 L/s 15,000 GPD and above.

Magnetic starters shall be provided for each blower motor, [(each) mechanical aerator motor,] [comminutor motor,] and froth control system pump motor, [sludge collector drive motor (when used)]. Magnetic starters shall have ambient compensated, bi-metallic overload heaters in each phase line. Reset buttons for magnetic starters shall be mounted on enclosure doors. Contactors shall be provided for [chlorinator housing heater] [hypochlorinator housing heating device].

2.12.6 Selector Switches, Pushbuttons, and Pilot Lights

Selector switches, pushbuttons, and pilot lights shall be mounted on the outside of the enclosure. One Hand-Off-Automatic (H-O-A) selector switch shall be provided for each motor starter. One selector switch shall be provided for changing lead blower in the lead-standby system. Selector switches shall be heavy-duty oil-tight type. Push buttons shall be provided for manual (Hand) operation of motors. Pilot lights shall be provided for each H-O-A selector switch: red to indicate motor is running and amber to indicate automatic operation. Connections to the selector switch shall be such that only the normal automatic regulating control devices will be by-passed when the switch is in the "Hand" position. All safety control devices such as motor overload protection devices shall be connected in the motor control circuit in both the "Hand" and "Automatic" positions.

2.12.7 Circuit Controls

NOTE: Delete last sentence when not necessary.

Circuit controls shall include the following: Program timer, 30-minute

percentage timer, thermostat, control circuit transformer, and all necessary relays and pressure switches to carry out the sequence of operation as specified hereinbefore. Program timer shall be 7-day type, electric motor driven, with each hour of the day shown. Time intervals shall be adjustable with a minimum switching interval of 4 hours. Percentage timer shall be 30-minute type. Thermostat shall have a range of zero to 38 degrees C and a differential of 1 degree C 100 degrees F and a differential of 7 degrees F; thermostat shall be provided with not less than 1.82 m 6 feet of capillary tubing. Control circuit voltage shall be 120 volts, single phase, 60 hertz. [A transformer shall be provided to step down incoming service voltage to 120 volts.]

2.12.8 Alarm

NOTE: Delete requirements for alarm circuit auxiliary contacts where transmission of alarm to remote 24-hour manned station is impractical or not desired. Transmission is preferred where necessary to expedite investigation of alarm condition. Insert identity of remote location. Provision should be made in the appropriate section of the project specification to extend alarm circuit wiring from auxiliary contacts to the remote location.

Horn type or 150 mm 6 inch bell alarm, battery and necessary circuits shall be provided to sound alarm: (a) when standby blower(s) has replaced lead blower; (b) when power to plant has been interrupted. [Alarm circuit shall include auxiliary contacts for transmission of signal indicative of either alarm condition to [____].]

2.12.9 Electrical Wiring

All control circuits shall be wired with 1.8 mm No. 14 gage stranded, 1 mm 2/64 inch insulation machine-tool wire with ring tongue compression type lugs and number tags on both ends of all wires. Circuit breakers and power circuits shall be wired with necessary gage wire, minimum size 2.5 mm No. 12 gage, with wire lugs and number tags. All wires shall be secured in a neat workmanlike manner with plastic tie-raps and/or wiring duct. All wires going to components mounted on the enclosure door shall be secured in a cable-like bundle and strapped to the door and the enclosure with sufficient slack to allow easy operation of the door. All circuits requiring field connection shall be terminated on panel terminals.

2.13 APPURTENANCES AND ACCESSORIES

2.13.1 Walkways, Platforms, and Bridges

NOTE: Delete references and requirements for raised platform floor plate or for grating as necessary. Grating is recommended where snow or ice accumulation may be anticipated; otherwise, use floor plate.

NOTE: Delete references and requirements for raised

platform floor plate or for grating as necessary.
Grating is recommended where snow or ice
accumulation may be anticipated; otherwise, use
floor plate.

NOTE: Delete references and requirements for raised
platform floor plate or for grating as necessary.
Grating is recommended where snow or ice
accumulation may be anticipated; otherwise, use
floor plate.

NOTE: Delete last sentence when steel plant only is
specified. Hypochlorinator should be specified for
all plants 4.38 L/s 100,000 GPD capacity and below.
Chlorinator should be specified for all plants 6.57
L/s 150,000 GPD capacity and above. Between 4.38
and 6.57 L/s 100,000 and 150,000 GPD capacity either
is suitable. Selection should be made on basis of
existing station or base practices, local
availability, and comparative costs.

Walkway(s) and platform(s) shall be provided for access to all plant
components where regular inspection and maintenance is necessary. Bridge(s)
shall be provided to support walkway(s) where necessary. Bridge support
beams shall be of sufficient size to limit deflection to 1/360 of the
span. Walkway(s) and platform(s) shall be skidproof [raised-pattern floor
plate] [grating]. Walkway(s) and platform(s) shall have a double railing
not less than 1.07 m 3 feet 6 inches in height on both sides of the walkway
and around the outside of the operating platform; railing shall be
structural steel section or of standard 38 mm 1 1/2 inch pipe conforming to
ASTM A 53/A 53M. Walkway shall be not less than 750 mm 30 inches wide.
[Raised-pattern floor plate] [grating] shall be of a design and material
thickness necessary to keep deflection to less than 6 mm 1/4 inch with a
uniform load of 3.6 kPa 75 pounds per square foot. [Floor plate shall be
zinc-coated steel.] [Gratings shall be zinc-coated steel with zinc coating
conforming to ASTM A 123/A 123M, aluminum conforming to ASTM B 221M
ASTM B 221, or fiberglass.] The maximum weight of each panel shall not
exceed 25 kg 55 pounds. Suitable non-metallic insulating spacers shall be
provided where necessary to prevent aluminum and steel from coming into
contact. Gratings shall be secured in place by saddle clips or as
recommended by the manufacturer for easy removal. [Supports in contact
with concrete shall be painted with alkaline-resistant coatings.]

[2.13.2 [Access Stairway] [Access Ladder]

NOTE: Delete references and requirements for access
ladder as Contractor's option unless it can be
justified on an economic and technical basis.
Although more expensive, a stairway is preferable in
that it provides safer and easier access to
platforms and walkways.

NOTE: Delete references and requirements for access ladder as Contractor's option unless it can be justified on an economic and technical basis. Although more expensive, a stairway is preferable in that it provides safer and easier access to platforms and walkways.

NOTE: Delete "raised platform floor plate" or "grating" as necessary. Delete references and requirements for raised platform floor plate or for grating as necessary. Grating is recommended where snow or ice accumulation may be anticipated; otherwise, use floor plate.

NOTE: Delete references and requirements for access ladder as Contractor's option unless it can be justified on an economic and technical basis. Although more expensive, a stairway is preferable in that it provides safer and easier access to platforms and walkways.

When top of plant is more than 600 mm 24 inches above surrounding ground level, an access stairway [or ladder] shall be provided. Stairway shall be fabricated of structural steel members. Steps shall be [raised-pattern floor plate] [grating]. [Access ladders shall be of steel or aluminum and shall be 450 mm 18 inches wide minimum, with step bars spaced 300 mm 12 inches on center. Ladders shall be anchored at bottom and top and intermediate points with brackets 1.8 m 6 feet apart. Brackets shall be of same size as side bars and of such length as to hold ladder 150 mm 6 inch away from walls. Curved returns shall be provided at top of ladder. Aluminum side bars and step bars shall conform to ASTM B 221M ASTM B 221.]

2.13.3 Handrails

Handrails shall be provided on stairways, platforms, bridges, and other points of personnel access for operation and inspection. A handrail shall be provided around the perimeter of the tank if the top of the exposed side wall is less than 1.07 m 3 feet 6 inches above grade. Handrails shall be constructed of structural steel section or of standard 38 mm 1 1/2 inch pipe conforming to ASTM A 53/A 53M.

2.13.4 Raw Sewage Recirculation Box

NOTE: Delete this paragraph when raw sewage recirculation box is considered unnecessary. When sewage is pumped to the treatment plant, the use of a raw sewage recirculation box (which recirculates a portion of incoming sewage back to the pumping station) should be considered to provide uniform flow and avoid surges through the plant. Decision should be based on undesirability of surge effects on the plant vs. economics of the recirculation

system.

Raw sewage recirculation box shall be fabricated of 6 mm 1/4 inch steel plate and shall have suitable sized connections for incoming raw sewage line, plant influent line, and recirculation line. Box shall have a fixed weir and an adjustable weir or other suitable means of flow regulation so that a portion of the incoming raw sewage may be recirculated. A removable or hinged cover shall be provided. Joints inside walls, bottom, and partitions shall be welded continuously inside and out. After welding, weld spatter and extreme roughness shall be removed. Inlet shall be not less than 200 mm 8 inch size.

2.13.5 Plant Influent Flow Division Box

NOTE: Delete this paragraph for extended aeration type 0.66 L/s 15,000 GPD and below and for all step aeration type and complete mixing type plants and extended aeration type when complete mixing type plants and extended aeration type when eventual conversion to step aeration type is contemplated.

When two or more aeration tanks are provided, a plant influent flow division box shall be provided. The box shall be fabricated of 6 mm 1/4 inch steel plate and shall have suitably sized connections for incoming raw sewage line and influent lines to each aeration tank. The box for dividing flow between two tanks shall have a hinged divider plate that will permit adjustment of from zero to 100 percent to either outlet. Divider plate shall have locking nut and handle. The box shall have a hinged cover with provisions for padlocking. All inside walls, bottom, and partitions shall be welded continuously inside and out. After welding, all weld spatter and extreme roughness shall be removed. Flow division boxes for more than two tanks shall be as specified herein, except that method of flow division shall be as recommended by the manufacturer of the plant.

2.13.6 Aeration Tank Influent Distribution Channel

NOTE: Delete this paragraph for extended aeration type except when eventual conversion to step aeration type is contemplated.

NOTE: Use first optional wording in fifth sentence for step aeration type and second optional wording for complete missing type.

The aeration tank influent distribution channel shall be continuously welded to the side of the tank wall. The bottom of the channel shall be at the same elevation as the liquid surface of the aeration tank. The inlet to the channel shall be at one point and not less than 200 mm 8 inches in diameter. The channel shall be fabricated of steel plate of not less than 6 mm 1/4 inch thickness. The channel shall be fabricated of steel plate of not less than 6 mm 1/4 inch thickness. The channel shall have [adjustable weirs or stop gates, not less than three in number, spaced the full length

of the channel] [multiple discharge openings] for uniform distribution to the aeration tank. The weir or stop gates shall be of stainless steel or aluminum. The gates shall have 40 durometer chloroprene gaskets on the bottom, with wedges or other means to insure a close fit. Guides for the gates shall be of the same material as the gates. The channel shall be of such size as to accommodate the peak flow to the plant.

2.13.7 Sludge Division Box

Sludge division box shall be provided to divide return sludge and waste sludge when this method of sludge transfer is used, as specified in paragraph entitled "Sludge Transfer System." The box shall be fabricated of 6 mm 1/4 inch steel plate and shall have a suitably sized connection for incoming sludge and outlets for return sludge and waste sludge. The box shall have a hinged plate or adjustable gate that will permit adjustment of flow from zero to 100 percent to either outlet. Plate or gate shall have locking nut and handle. A weir shall be provided on each outlet. Box shall be adequately covered and/or baffled to prevent splashing of the sludge. All joints between walls, bottom, and partitions shall be welded continuously inside and out. After welding, all weld spatter and extreme roughness shall be removed.

2.13.8 Settling Tank Effluent Weir and Scum Baffle

Weir and scum baffles shall be stainless steel, ASTM A 176 or ASTM A 167 steel, ASTM A 36/A 36M, or aluminum ASTM B 209M ASTM B 209 or ASTM B 221M ASTM B 221, alloy 6061, temper T6. Weirs shall be U- or V-notched 1.57 rad 90 degreestriangular-type and of a size and section for structural stability to handle peak flows through the plant. The upstream face of the weir plate shall be flat and smooth. Weir plates and baffle supports shall have slotted or oversized holes and plate washers to permit horizontal and vertical adjustment of the weir and baffle. Weir plates shall be mounted against a double bead of two-component polysulfide-rubber-base sealant of sufficient thickness to fill any voids between the concrete tank and the weir plate.

2.13.9 Mixer for Return Sludge Mixing

NOTE: Delete this paragraph and subparagraphs thereto except for complete mixing type.

2.13.9.1 General

Mixer shall be vertical type and shall include drive assembly, impeller shaft and impellar, and support. The mixer shall be designed to continuously mix raw sewage with return sludge continuously so that the mixture will be homogeneous. The mixer shall be designed for the average design flow through the plant.

2.13.9.2 Drive Assembly

NOTE: Insert electrical power characteristics.

Mixer driver assembly shall include an electric motor connected to a gear reduction unit whose output shaft is directly connected to the mixer

impeller shaft. Motor shall be constant speed, totally enclosed, fan-cooled horizontal type, suitable for outdoor service, and conforming to NEMA MG 1. The motor shall be of adequate wattage horsepower to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [_____] volt, [_____] phase, [_____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. Power transmission from motor to impeller shaft shall be by means of a vertical or a right angle gear reduction unit. Reduction ratio shall be such as to produce the proper operating speed for the mixer. Gear reduction unit shall be designed to withstand any loadings produced by thrust, out-of-balance, and vibration resulting from operating conditions and shall operate from zero rpm to a speed compatible with the impeller speed. All components shall be designed to withstand continuously the full load motor wattage horsepower. Gearing may be spur, helical, spiral, bevel, worm or a combination thereof. All gears shall be wrought or alloy steel except that worm gears shall be bronze. The gear teeth may be through-hardened, contour-induction-hardened, nitrided, or carburized. Flame-hardened gears will not be acceptable. The housing shall be of high quality, close-grained cast iron or fabricated steel. A lubrication system shall be provided for the gears. Bearings may be lubricated with oil or grease. Base plate or mounting lugs shall be of steel or integrally cast with the gear reduction unit and shall be furnished with leveling anchor bolts with lock nuts.

2.13.9.3 Impeller and Impeller Shaft Coupling

The gear reduction unit output shaft shall be connected to the flash mixer impeller shaft by means of a rigid carbon steel coupling of the bolted flange type. The coupling shall be located above the maximum liquid operating level of the basin. All nuts, bolts and washers shall be made from Type 316 stainless steel. The impeller shaft shall be of sufficient diameter to withstand the loading imposed by the impeller, using a safety factor of 1.5. The shaft shall be of solid steel construction, AISI Type 304 stainless steel. A key seat shall be provided to fit the key specified for attachment of impeller; key seat shall conform to ASME B17.1 or ASME B17.2 as appropriate. Impeller shall be fabricated from corrosion-resisting material. The impeller shall be of a shape that will effectively mix the raw sewage and sludge. Impeller shall be keyed and bolted to the impeller shaft with Type 316 stainless steel bolts and shall be readily adjustable on the shaft keyway and removable from the shaft.

2.13.10 Anchor and Connection Bolts

Nuts and washers shall be cadmium-plated steel or stainless steel. Bolt sizes and locations shall be as indicated on the manufacturer's certified prints of the equipment furnished unless otherwise specified or indicated. The manufacturer shall furnish templates to accurately position bolts in multiple bolt installations. Aluminum shall be attached with stainless steel machine bolts conforming to AISI type 302 or ASTM A 320/A 320M. Iron or steel shall be attached with cadmium plated steel machine bolts conforming to ASTM A 307.

2.13.11 Plant Anchorage

Materials necessary for anchorage of the plant to the concrete support slab shall be as recommended by the manufacturer of the plant.

2.14 UTILITIES SERVICE CONNECTIONS

2.14.1 Water Service

NOTE: Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 and 6.57 L/s 100,000 and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

NOTE: Specify in the appropriate section of project specification the nearest point of connection to the plant, and also type of connection available.

NOTE: Delete reference either to chlorinator or to hypochlorinator.

NOTE: Delete reference to "Frost-proof" for plants in areas where freezing temperatures are not encountered.

NOTE: Delete reference either to chlorinator or to hypochlorinator.

Water line shall be a 25 mm one inch copper water line extending from a point not less than 1.52 m 5 feet from the treatment plant to the [hypochlorinator housing] [chlorinator]. A 25 mm one inch valve in a [frost-proof] valve box shall be provided below grade. A 19 mm 3/4 inch hose bibb shall be provided in the [hypochlorinator] [chlorinator] housing.

2.14.2 Electrical Service

An electric service line shall be provided from a point not less than 1.52 m 5 feet from the treatment plant to the electrical control system enclosure.

2.15 CATHODIC PROTECTION

NOTE: Delete the paragraph when concrete plant only is specified. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first

cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

Cathodic protection shall be provided for the steel-fabricated sewage treatment plant when installed below grade. This protection shall consist of installing one 7.71 kg 17 pound magnesium anode package not less than every 7.62 m 25 feet along the outer steel shell of the plant. The anodes shall be securely connected with solderless electrical connectors to the shell with not less than No. 8 copper wire, factory installed.

2.16 TREATMENT AND PAINTING

NOTE: Delete reference to comminutor when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete requirement for aeration tank detention time when complete mixing type is specified.

NOTE: Delete reference either to chlorinator or to hypochlorinator. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 and 6.57 L/s 100,000 and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

Except as otherwise specified, equipment shall be treated and painted in accordance with the manufacturer's standard practice. All exposed surfaces of ferrous metals, other than piping, including those to be submerged, shall be sandblasted in accordance with SSPC SP 6/NACE No.3 and shop coated with two coats of epoxy polyamide conforming to SSPC Paint 16 applied to a minimum dry film thickness of 0.20 mm 8 mils per coat. The maximum time between coats shall be 72 hours. The following items shall be finished in accordance with manufacturer's standard practice suitable for end use

environment: blowers, motors, gearmotors, motor-driven speed reducers, shafts, [comminutor] [chlorinator] [hypochlorinator] and pushbutton stations. Aluminum shall have an AA-CC-22-A41 finish. Stainless steel, stellite and nonferrous metals shall not be coated. Exposed surfaces of concrete tanks shall be provided with two coats of rubber-based paint, gloss or semi-gloss, conforming to CID A-A-3120. Blower housing, [chlorinator] [hypochlorinator] housing, and electrical control system enclosure shall be cleaned and sanded. Any external marks or scratches that remain after sanding shall be filled with an epoxy plastic resin and then ground smooth leaving a smooth level surface. All surfaces of housings and enclosures shall be coated with zinc-molybdate primer conforming to FS TT-P-645, and finish coat conforming to MIL-PRF-24635 or FS TT-E-1593, color as directed. All exterior surfaces of piping which subject to total or intermittent submersion shall be given a vinyl paint system in accordance with SSPC PS 4.02. All exterior surfaces of piping that is not subject to submersion or which is buried shall be given a coal tar coating system in accordance with SSPC PS 10.01.

2.17 ELECTRICAL REQUIREMENTS

Electrical components of mechanical equipment and systems such as motors, starters, chart drives, electrical disconnecting (isolating) means, and controls shall be provided under this section and shall be as specified herein and as necessary for complete and operable systems. Motors shall conform to NEMA MG 1. Interconnecting wiring for factory-wired plant components shall be provided as an integral part of the plant. All interconnecting power wiring and conduit for field erected plant components and control wiring, rated over 100 volts, and conduit shall conform to the requirements of Division 26. Wiring of signal circuit shall be provided as recommended by the equipment manufacturer. The work shall be in accordance with NFPA 70.

2.18 SOURCE QUALITY CONTROL

NOTE: When two or more 22.0 L/s 0.5 MGD or four or more 11 L/s 0.25 MGD sewage treatment plants are contracted for at one time, select the alternative to witness the factory tests.

All factory tests shall be conducted by the manufacturer of the package sewage treatment plant [in the presence of the [Contracting Officer] [Contractor Quality Control representative]].

2.18.1 Mechanical Aerator

NOTE: Delete paragraph and subparagraph thereto when step aeration type or complete mixing type is specified, or when mechanical aerator is not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type

where eventual conversion to step aeration is contemplated.

a. **Mechanical Aerator Oxygenation Capacity Tests:** Oxygenation capacity tests shall be performed in a test tank that is baffled to the size and configuration of the aeration tank to be used. Tests shall be performed as follows:

- (1) The test tank shall be thoroughly cleaned and then filled with fresh tap water.
- (2) The temperature of the fresh water shall be as close to 20 degrees C 68 degrees F as possible.
- (3) The aerator(s) shall be set at its maximum submergence with the shroud in place.
- (4) Submersible sample pumps shall be installed at three operating depths, 2.4 m, 1.8 m, 1.2 m 8 ft., 6 ft. and 4 ft. depths at two selected locations in the basin, on opposite sides of the tank, one at 1/4 the distance from center of tank, and the other at 3/4 the distance from the center.
- (5) A catalyst, chloride or sulfate, shall be dissolved in the tank contents, with the aerator running to insure mixing, to a minimum concentration of 2 mg/l of cobalt ion.
- (6) After the aerator has reached a steady state condition for 30 minutes, a sodium sulfite solution, which removes the D.O., shall be released into the tank contents at the impeller. For a liquid having an initial D.O. concentration of 10 parts per million (ppm) approximately one pound of dry sodium sulfite will be required per 3780 L 1,000 gallons of liquid per test. This will provide an excess to compensate for oxidation during mixing.
- (7) As the D.O. rises in the tank, six samples, one for each depth at each location, shall be drawn at one to five minute intervals. Intervals should be selected to get at least six sets of samples between 10 and 90 percent saturation. The D.O. shall be run by the Azide Modification of the Iodometric Method as described in AWWA 10084 and an average obtained on the samples for each sampling time.
- (8) While the aerator is running, electrical measurements shall be made on the input with a recording wattmeter.
- (9) A semi-log plot of the data of the D.O. deficit against time shall be constructed. Only points between 10 and 90 percent saturation shall be considered. A line of best fit shall be drawn through the plotted points.
- (10) The slope of the line shall be calculated.
- (11) Corrections shall be made for temperature, oxygen saturation of the water, and the relative transfer coefficient of the water and then the pounds of oxygen dissolved at standard conditions of 20 degrees C 68 degrees F, tap water, and "0" ppm dissolved concentration shall be computed.

- (12) The efficiency of the aerator shall be determined by dividing the **kg pounds** of oxygen dissolved per hour under standard conditions by the input **wattage horsepower**.
- (13) After tests have been made to prove that the oxygenation capacity at maximum submergence of the aerator(s) meet(s) specified requirements, tests shall be repeated to establish oxygenation capacity at liquid levels **75 mm and 150 mm 3 inches and 6 inches** below maximum submergence. The tests shall be those specified herein.
- (14) Should aerator(s) fail to produce the oxygenation capacity required, the test series shall be repeated.
- (15) If the required oxygenation capacity is not produced after two test repetitions, the Contractor shall either correct the defective unit(s) or replace them with new unit(s), and the test procedure shall be repeated as set forth herein, until satisfactory units are obtained.

b. **Mixing Test for Mechanical Aerator:**

Mixing Velocity Test: Mixing test shall be conducted in the same tank and at the same time as the oxygenation capacity test.

- (1) Velocity measurements shall be made throughout the tank when aerator(s) is in service under actual operating conditions to test for complete mixing of tank contents.
- (2) Measurements shall be taken at the quarter points of each tank wall, **0.60 m 2 feet** from the wall, and at the levels of the sample pumps used in oxygenation capacity tests. Minimum velocity shall be **0.18 meters per second 0.6 fps**. Measurements shall be taken with a Price current meter.
- (3) Should any of the velocity measurements fall below the specified minimum velocity, the test shall be repeated.
- (4) If the specified minimum velocity is not produced after two test repetitions, the Contractor shall either correct the defective unit(s) or replace them with new Unit(s), and the test procedure shall be repeated as set forth herein, until satisfactory units are obtained.

2.18.2 Fine Bubble Diffusers

2.18.2.1 Porous Ceramic Tube Diffusers

- a. **Oxygen Absorption for Porous Ceramic Tube Diffusers:** Prior to starting production of porous ceramic tube diffusers, the manufacturer shall furnish three sample tubes of the type to be furnished for installation. The sample tubes shall be tested for oxygen absorption by the manufacturer and shall be selected at random by him.
 - (1) The oxygen absorption rating test shall be made in a tank. The tank shall be **1.05 m 3 feet 6 inches** long by **475 mm one foot 7 inches** wide, holding approximately **473 L 125 gallons**. The tank shall be filled with tap water, at **22.2 degrees C 72 degrees F**, to

a depth of 900 mm 3 feet 0 inches, covering the top of the diffuser tube. Sodium sulfite, to the amount of 1200 ppm, and 66 Baume scale sulfuric acid, to the amount of 55 ppm, shall be dissolved in the water. The sulfite shall be put into solution by removing some of the water from the tank, dissolving the sulfite in this water and then pouring it back into the tank while air is being diffused into the solution in the tank as to insure a thorough mixing.

- (2) Each diffuser tube to be rated for oxygen absorption shall be submerged in tap water for one hour or more just prior to the rating test. The tube shall then be clamped to the tube holder, lowered into the tank to just below the solution and inspected with the air diffusing. Any leaks along the gasket shall be eliminated by additional tightening of the clamps. The container with tube attached shall then be lowered to the tank bottom for the rating test. With air diffusing from the tube at 0.59 L/s 1.25 cfm measured as air at 99.3 kPa 14.4 psi absolute pressure and 15.5 degrees C 60 degrees F, samples of the solution shall be taken every 10 minutes for 40 minutes. These samples shall be immediately tested for oxygen absorption. The oxygen absorption rate for a 40-minute period, in which the indicated rate in any 10-minute interval does not vary more than 10 percent from the average, shall be the oxygen absorption rating of the tube.
- (3) No oxygen absorption rating tests shall be made when the uncovered sodium sulfite concentration in the tank is lower than 300 ppm.
- (4) The oxygen absorption rating shall be determined by measuring the rate of conversion of sodium sulfite to sodium sulfate due to the oxygen absorption taking place in the solution. This is done by taking 50 cubic centimeter (cc) samples of the solution at intervals and adding to each sample such a fixed amount of acidified iodine solution that there is always iodine in excess of the amount required to neutralize the sulfite. The change in sulfite concentration is determined by measuring the change in the excess iodine for each interval. This is done by titrating the excess iodine with N/40 sodium thiosulfate. For a 50 cc sample of the solution, a titration difference of 1.0 cc of sodium thiosulfate is equivalent to 4.0 ppm of oxygen absorption.
- (5) The results obtained by the foregoing testing procedures shall be multiplied by a correction factor determined as follows: Air shall be diffused into 14 L 0.5 cubic foot or less of distilled water at 75 mm 3 inches depth for a period of two hours in which the barometric pressure and water temperature remain constant. D.O. determinations shall then be made on samples from the water by the Azide Modification of the Iodometric Method, as described in AWWA 10084, using sodium thiosulfate solution, the same as used in the tube rating test. The D.O. thus obtained in ppm, divided into the solubility of oxygen in ppm in water, for the barometric pressure and water temperature which shall be obtained for the two hour test period, shall constitute the correction factor. The solubility of oxygen in the water shall be that as indicated for fresh water by AWWA 10084 for the particular condition of barometric pressure and water temperature.
- (6) If the results of the oxygen absorption test are satisfactory,

the production of tube diffusers may be started. If the tubes tested fail to meet the oxygen absorption specifications, details of manufacture shall be altered or other corrective measure taken and three sample tubes shall again be selected and tested. This procedure shall be repeated until the proper porous structure is obtained to meet the specifications. After production of tubes has begun, three tubes selected at random from each tube lot procured for the contract shall again be tested for the oxygen absorption rating. Should any one of these samples fail to meet the specifications, additional tubes of the same tube lot represented by the samples, selected as directed by the [Contracting Officer] [Contractor Quality Control representative] shall be submitted for a check test. If any one of the check samples fails to meet the specifications, the entire lot of tubes represented by the samples shall be rejected.

- b. **Physical Properties Tests:** All tubes to be furnished shall be tested for physical dimensions, shape and bonding characteristics. Testing frames, maximum and minimum dimension gages and squares shall be provided by the manufacturer. All tubes with dimensions outside the specified range, with appreciable warping of surface showing cracks, soft spots, chipping or other defects, or not free from adhering foreign material, dirt, oil and clogging material will be rejected. All tubes shall be tested to a 95 percent confidence level sampling plan. Tubes actually tested shall have their ratings so marked upon them. All tubes shall be marked and include the acceptance mark of the supplier.
- c. **Permeability for Porous Ceramic Tube Diffusers:** The permeability rating shall be the number of L/s cfm of free air, at 21.1 degrees C 70 degrees F and 10 to 25 percent relative humidity, which will pass through 300 mm square one square foot of tube area, to the atmosphere under a differential pressure equivalent to 50 mm two inches of water below the tube when the tube is tested dry at 21 degrees C 70 degrees F.

Detail requirements for the apparatus shall be as follows:

- (1) Free air shall be interpreted to mean air at an absolute pressure equal to the barometric pressure at the time of testing.
- (2) All tubes furnished shall be individually inspected and rated.
- (3) The permeability rating apparatus shall consist essentially of a container for testing the tubes individually; meter with a large easily read scale for measuring the flow of air to the tube, pressure gage for indicating the pressure at the tube; recording thermometers for the test air; and the necessary controlling devices. The container or test box shall be provided with suitable clamping devices for holding the tube in position and completely sealing the tube against the passage of air except through the exposed face. The container shall be arranged to distribute the air uniformly through the tube from the air inlet; inlet shall be not less than 75 mm 3 inches in diameter.
- (4) The meter shall be of the orifice type, of proper size, and installed in accordance with the recommendation of AGA GMC. Before tube tests are started, the calibration of the orifice meter shall be checked with a standard displacement type gas meter of not less than 39.33 L/s 5,000 cubic feet per hour (cfh)

capacity which has been accurately calibrated volumetrically in a manner satisfactory to the [Contracting Officer] [Contractor Quality Control representative]. When checking the orifice meter, the inlet of the standard gas meter shall be connected to an opening in a steel plate clamped in the test box and the outlet of the gas meter shall be to the atmosphere. The checking of the orifice meter shall be done in the presence of the [Contracting Officer] [Contractor Quality Control representative]. The calibration of the orifice meter may be checked with an orifice plate, calibrated as described above, suitably arranged for clamping into the test box.

- (5) The test air supply shall be such as to give a continuous nonpulsating flow of air with a relative humidity between 10 and 25 percent. A suitable equalizing tank and moisture control equipment, with recording hygrometer, shall be provided for the purpose.
- (6) Each diffuser tube shall be tested dry for its permeability rating. All tubes shall be kept dry from the time they leave the kiln until tested.
- (7) Each diffuser tube shall have practically uniform permeability throughout its face area, free from dead areas or areas with large bubbles, as determined visually by the method of testing hereinafter specified.
- (8) The uniformity testing apparatus shall be similar to the permeability rating apparatus, and shall provide for submerging the tube under 25 mm one inch of water after it is clamped into position.
- (9) Diffuser tubes to be tested for uniformity shall be saturated with tap water, clamped in position in the apparatus, and submerged to a depth of 25 mm one inch with tap water. Air shall then be diffused through the tube at a rate of 61 L/s per square meter 12 cfm per square foot for one minute. The rate of air flow shall be reduced to 5 L/s per square meter 1.0 cfm per square foot, the uniformity of diffusion observed and recorded as satisfactory or rejected.
- (10) Uniformity tests will be required on not less than one tube selected at random from each 100 accepted for permeability. If these tests do not show substantial uniformity, such additional tests shall be made as may be necessary to assure the [Contracting Officer] [Contractor Quality Control representative] that tubes with uniform permeability are being obtained. If the additional tests indicate that 10 percent or more of the tubes are non-uniform, the entire 100-tube batch shall be tested individually for uniformity, and the additional cost of such inspection shall be borne by the Contractor.
- (11) All diffuser tubes furnished under this contract shall have sufficient strength to carry a load equivalent to a 4.50 m 15 foot depth of water, with a safety factor of not less than 1.7, and to withstand the stresses of reasonable handling and shipping.

2.18.2.2 Porous Plastic Tube Diffuser Tests

Porous plastic tube diffusers shall be subjected to the following tests:

- a. **Oxygen Absorption for Porous Plastic Tube Diffusers:** Prior to starting production of plastic tube diffusers, the manufacturer shall furnish three sample tubes of the type to be furnished for installation. The sample tubes shall be tested for oxygen absorption by the manufacturer and shall be selected at random by him. Detailed test requirements are as follows:
 - (1) The oxygen absorption rating test shall be made in a tank. The tank shall be 1.05 m 3 feet 6 inches long by 475 mm one foot 7 inches wide, holding approximately 473 L 125 gallons. The tank shall be filled with tap water, at 22.22 degrees C 72 degrees F, to a depth of 900 mm 3 feet 0 inches, covering the top of the diffuser tube. Sodium sulfite to the amount of 1,200 ppm and 66 Baume scale sulfuric acid to the amount of 50 ppm, shall be dissolved in the water. The sulfite shall be put into solution by removing some of the water from the tank, dissolving the sulfite in this water and then pouring it back into the tank while air is being diffused into the solution in the tank to insure a thorough mixing.
 - (2) Each diffuser tube to be rated for oxygen absorption shall be submerged in tap water for one hour or more just prior to the rating test. The tube shall then be clamped to the tube holder, lowered into the tank to just below the solution, and inspected with the air diffusing. Any leaks along the gasket shall be eliminated by additional tightening of the clamps. The container with tube attached shall then be lowered to the tank bottom for the rating test. With air diffusing from the tube at 0.59 L/s 1.25 cfm, measured as air at 99.3 kPa 14.4 psi absolute pressure and 15.55 degrees C 60 degrees F, samples of the solution shall be taken every 10 minutes for 40 minutes. These samples shall be immediately tested for oxygen absorption. The oxygen absorption rate for a 40-minute period, in which the indicated rate in any 10-minute interval does not vary more than 10 percent from the average, shall be the oxygen absorption rating of the tube.
 - (3) No oxygen absorption rating tests shall be made when the uncovered sodium sulfite in the solution in the tank is lower than 300 ppm.
 - (4) The oxygen absorption rating shall be determined by measuring the rate of conversion of sodium sulfite to sodium sulfate due to the oxygen absorption taking place in the solution. This shall be done by taking 50 cc samples of the solution at intervals and adding to each sample such a fixed amount of acidified iodine solution that there is always iodine in excess of the amount required to neutralize the sulfite. The change in sulfite concentration shall be determined by measuring the change in the excess iodine with N/40 sodium thiosulfate. For a 50 cc sample of the solution, a titration difference of 1.0 cc of sodium thiosulfate is equivalent to 4.0 ppm of oxygen absorption.
 - (5) The results obtained by the foregoing testing procedures shall be multiplies by a correction factor determined as follows: Air shall be diffused into 14 L 0.5 cubic feet or less of distilled water at

75 mm 3 inches depth for a period of two hours in which the barometric pressure and water temperature remain constant. D.O. determinations shall then be made on samples from the water by the Axide Modification of the Iodometric Method, as described in AWWA 10084, using sodium thiosulfate solution the same as used in the tube rating test. The D.O. thus obtained, in ppm, divided into the solubility of oxygen in ppm in water, for the barometric pressure and water temperature which were obtained for the two hour test period, shall constitute the correction factor. The solubility of oxygen in the water shall be that as indicated for fresh water by AWWA 10084, for the particular condition of barometric pressure and water temperature.

- (6) If the results of the oxygen absorption test are satisfactory, the production of tube diffusers may be started. If the tubes tested fail to meet the oxygen absorption specifications, details of manufacture shall be altered or other corrective measures taken and three sample tubes shall again be selected and tested. This procedure shall be followed until the proper porous structure is obtained to meet the specifications. After production of tubes has begun, three tubes selected at random from each tube lot produced for the contract shall again be tested for the oxygen absorption rating. Should any one of these samples fail to meet the specifications, additional tubes of the same tube lot represented by the samples, selected as directed by the [Contracting Officer] [Contractor Quality Control representative] shall be submitted for a check test. If any one of the check samples fails to meet the specifications, the entire lot of tubes represented by the samples shall be rejected.
 - (7) All accepted tubes shall be suitably marked or stamped by the manufacturer. Tubes not bearing the rating marks will not be approved for installation.
- b. Permeability for Porous Plastic Tube Diffusers: The permeability rate shall be the number of L/s cfm of free air, at 21.1 degrees C 70 degrees F and 10 to 25 percent relative humidity, which will pass through 0.09 square meter one square foot of tube area, to the atmosphere under a differential pressure equivalent to 50 mm two inches of water below the tube when the tube is tested dry at 21.1 degrees C 70 degrees F. Detailed test requirements are as follows:
- (1) Free air shall be interpreted to mean air at an absolute pressure equal to the barometric pressure at the time of testing.
 - (2) Tubes showing permeability ratings outside the specified range will be rejected. Each tube within the specified range shall be plainly marked with its permeability rating to the nearest 5 L/s per square meter 1.0 cfm per square foot.
 - (3) The permeability rating apparatus shall consist essentially of a container for testing the tubes individually, a meter with a large easily read scale for measuring the flow of air to the tube, pressure gage for air, and the necessary controlling devices. The container, or test box, shall be provided with suitable clamping devices for holding the tube in position and completely sealing the tube against the passage of air except through the exposed face. The plate supports and clamping devices shall be so designed that no less than 0.064 square meter 100 square inches of

the top and bottom of the tube will be exposed for the passage of air, and the top and bottom areas shall be equal and concentric. The container shall be arranged to distribute the air uniformly through the tube from the air inlet; and the inlet shall be not less than 75 mm 3 inches in diameter.

- (4) The meter shall be of the orifice type, of proper size, and installed in accordance with the recommendation of AGA GMC. Before tube tests are started, the calibration of the orifice meter shall be checked with a standard displacement type gas meter of not less than 31.47 L/s 4,000 cfh capacity which has been accurately calibrated volumetrically in a manner satisfactory to the [Contracting Officer] [Contractor Quality Control representative]. When checking the orifice meter, the inlet of the standard gas meter shall be connected to an opening in a steel plate clamped in the test box and the outlet of the gas meter shall be to the atmosphere. The checking of the orifice meter shall be done in the presence of the [contracting Officer] [Contractor Quality Control representative]. When checking the orifice meter, the inlet of the standard gas meter shall be connected to an opening in a steel plate clamped in the test box and the outlet of the gas meter shall be to the atmosphere. The checking of the orifice meter shall be done in the presence of the [contracting Officer] [Contractor Quality Control representative]. The calibration of the orifice meter may be checked with an orifice plate, calibrated as described above, suitably arranged for clamping into the test box.
- (5) The test air supply shall be such as to give a continuous non-pulsating flow of air with a relative humidity between 10 and 25 percent. A suitable equalizing tank and moisture control equipment, with recording hygrometer, shall be provided for the purpose.
- (6) Each diffuser tube shall be tested dry for its permeability rating.
- (7) In order to establish correction factors for actual testing conditions, duplicate sets of reference or "master" tubes shall be carefully rated at the time the flow meter is calibrated and used for comparison as hereinafter specified. Each set of master tubes shall consist of three diffuser tubes with permeability rating of 37.0, 40.0, and 43.0, respectively, for Type A tubes, and 24.0, 26.0 and 28.0, respectively, for Type B tubes. A tolerance of 0.5 plus or minus will be allowed on each permeability rating. The master tubes shall be rated in the presence of the [Contracting Officer] [Contractor Quality Control representative] at the standard temperature of 21.11 degrees C 70 degrees F for the test air and the plates, with the test air within the specified range of 10 to 25 percent relative humidity and the barometric pressure prevailing at the same relative humidity within the specified range.
- (8) Each day during the testing of a batch of tubes, one set of master tubes shall be given a check rating in the permeability apparatus, (1) at the start, (2) whenever testing conditions change, and (3) at intervals of not more than four hours. The variation of the apparent rating from the true rating of the master tubes shall then be applied as a correction factor to the

apparent rating of all tubes testing during the subsequent period in order to determine the correct rating to be marked on each. Where the master tubes show different correction factors, the correction for the master tube nearest the permeability to the tube being tested shall be used.

- (9) Because the master meter reading for each tube tested will be the rate for the tube area exposed in the test box, that reading shall be corrected to a rating based upon 0.09 square meter one square foot of tube area.
- (10) The master tubes shall be guarded against moisture, dirt or anything that might affect their rating. Only one set of master tubes shall be used at a time, and the duplicate set shall be stored in a dry, safe place. The set of master tubes in use shall be kept in the testing room and placed with the tubes to be tested in order that they may assume the same conditions as the tubes to be tested before a check rating is made.

2.18.3 Coarse Bubble Diffusers

2.18.3.1 Non-porous Nozzle Diffuser Tests

Nonporous nozzle diffusers shall be subjected to the following tests:

- a. **Oxygen Absorption for Non-Porous Nozzle Diffusers:** Prior to starting production of nozzle diffusers, the manufacturer shall furnish three samples of the type to be furnished for installation. The sample nozzles shall be tested for oxygen absorption by the manufacturer and shall be selected at random by him. Detailed test requirements are as follows:
 - (1) The oxygen absorption rating test shall be made in a tank. The tank shall be 1.05 m 3 feet 6 inches long by 475 mm one foot 7 inches wide, holding approximately 473 L 125 gallons. The tank shall be filled with tap water, at 22.22 degrees C 72 degrees F, to a depth of 900 mm 3 feet 0 inches, covering the top of the nozzle. Sodium sulfite to the amount of 1,200 ppm, and 66 Baume scale sulfuric acid to the amount of 50 ppm, shall be dissolved in the water. The sulfite shall be put into solution by removing some of the water from the tank, dissolving the sulfite in this water and then pouring it back into the tank while air is being diffused into the solution in the tank to insure a thorough mixing.
 - (2) Each diffuser nozzle to be rated for oxygen absorption shall be clamped to the nozzle holder, lowered into the tank to just below the solution and inspected with the air diffusing. Any leaks along the gasket shall be eliminated by additional tightening of the clamps. The container with nozzle attached shall then be lowered to the tank bottom for the rating test. With air diffusing from the nozzle at 3.78 L/s 8 cfm, measured as air at 99.3 kPa 14.4 psi absolute pressure and 15.5 degrees C 60 degrees F, samples of the solution shall be taken every 10 minutes for 40 minutes. These samples shall be immediately tested for oxygen absorption. The oxygen absorption rate for a 40-minute period, in which the indicated rate in any 10-minute interval does not vary more than 10 percent from the average, shall be the oxygen absorption rating of the clamps.

- (3) No oxygen absorption rating tests shall be made when the uncovered sodium sulfite in the solution in the tank is lower than 300 ppm.
- (4) The oxygen absorption rating shall be determined by measuring the rate of conversion of sodium sulfite to sodium sulfate due to the oxygen absorption taking place in the solution. This is done by taking 50 cc samples of the solution at intervals and adding to each sample such a fixed amount of acidified iodine solution so that there is always iodine in excess of the amount required to neutralize the sulfite. The change in sulfite concentration shall be determined by measuring the change in the excess iodine for each interval. This shall be done by titrating the excess iodine with N/40 sodium thiosulfate. For a 50 cc sample of the solution, a titration difference of 1.0 cc of sodium thiosulfate is equivalent to 4.0 ppm of oxygen absorption.
- (5) The results obtained by the foregoing testing procedures shall be multiplied by a correction factor determined as follows: Air shall be diffused into 14 L 0.5 cubic foot or less of distilled water at 75 mm 3 inches depth for a period of two hours during which the barometric pressure and water temperature remain constant. D.O. determination shall then be made on samples from the water by the Axide Modifications of the Iodometric Method, as described in AWWA 10084, using sodium thiosulfate solution the same as used in the tube rating test. The D.O., thus obtained in ppm, divided into the solubility of oxygen in ppm in water, for the barometric pressure and water temperatures which shall be obtained for the two hour test period, shall constitute the correction factor. The solubility of oxygen in the water shall be that as indicated for fresh water by AWWA 10084, for the particular condition of barometric pressure and water temperature.
- (6) If the results of the oxygen absorption test are satisfactory, the production of nozzle diffusers may be started. If the nozzles tested fail to meet the oxygen absorption specifications, details of manufacture shall be altered and other corrective measure taken and three sample nozzles shall again be selected and tested. This procedure shall be followed until the proper structure is obtained to meet the specifications. After production of nozzles has begun, three nozzles selected at random from each nozzle lot produced for this contract shall again be tested for the oxygen absorption rating. Should any one of these samples fail to meet the specifications, additional nozzles of the same nozzle lot represented by the samples, selected as directed by the [Contracting Officer] [Contractor Quality Control representative], shall be submitted for a check test. If any one of the check samples fails to meet the specifications, the entire lot of nozzles represented by the samples shall be rejected.
- (7) All accepted nozzles shall be suitably marked or stamped by the manufacturer. Nozzles not bearing the rating mark will not be approved for installation.

2.18.4 Air Blower Tests

The air blower shall be subjected to the following tests at the factory by the manufacturer: (1) The casing shall pass a hydrostatic pressure test at a minimum gage pressure of 112 kPa 25 psig; (2) The impeller, before

being mounted on the shaft, shall pass an over-speed spin test to a rotational speed of 120 percent of design speed; (3) After the spin test, the impeller shall pass an inspection for weld or other structural imperfections using magnetic particle techniques or x-rays; (4) The blower shall be given a running test using manufacturer's driver. During this test, mechanical operation of all equipment shall be satisfactory. Vibration shall meet the limits specified herein, and the overall sound pressure level shall be determined, making due allowance for any background noise during the running of the tests; (5) The blower shall be tested in accordance with ASME PTC 9 using manufacturer's driver and the temperature rise method of determining wattage horsepower. Tests shall include determination of the surge point and the shape of the characteristic curves at various inlet guide vane positions, and the determination of all data required to evaluate efficiencies and wattage horsepower requirements for the specified conditions. At least ten days prior to the manufacturer's running tests (4) and (5) above, the Contractor shall notify the Contracting Officer when these tests are to be performed so that arrangements can be made for a representative of the Government to witness the tests.

2.18.5 Operation Tests for Electrical Control Panel

The electrical control panel shall be rigidly shop tested for compliance with all applicable drawings and specifications. The test shall include energizing all circuits and performing the operating sequence, simulating field operations.

PART 3 EXECUTION

3.1 DESIGN

NOTE: Insert value for design flow. On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.
3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.

10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

NOTE: Insert value for 5 day BOD loading. This value should be based on tests of the sewage to be treated; however, if this cannot be obtained, use 200 mg/L.

NOTE: Insert value for total suspended solids. This value should be based on tests of the sewage to be treated; however, if this cannot be obtained, use 200 mg/L.

NOTE: Delete reference to comminutor and screening basket when not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

NOTE: Delete reference to influent distribution channel for extended aeration type.

NOTE: Delete requirement for aeration tank detention time when complete mixing type is specified.

NOTE: For detention time in aeration tank, insert 24 hours for extended aeration type and 5.0 to 7.5 hours for step aeration type.

NOTE: For organic loading in aeration tank, insert 5.67 kg 12.5 pounds, 5 day BOD for extended aeration type, 13.6 to 22.1 kg 30 to 50 pounds, 5-day BOD for step aeration type, and 52.16 kg 115 pounds, 5-day BOD for complete mixing type mixing type. Organic loadings used in this specification are those for sewage strength of 200 mg/l. Organic loadings for higher strength sewage would be proportional. Insert value for 5 day BOD loading. This value should be based on tests of the sewage to be treated; however, if this cannot be obtained, use 200 mg/L.

NOTE: Delete requirement for settling tank detention time when complete mixing type is specified.

NOTE: For detention time in settling tank for extended aeration type, insert 4.0 hours for plants of less than 2.19 L/s 50,000 GPD, 3.6 hours for plants from 2.19 L/s 50,000 GPD to 6.57 L/s 150,000 GPD capacity, and 3.0 hours for plants of 6.57 L/s 150,000 GPD capacity and above. For step aeration type, insert 3.0.

NOTE: For extended aeration type, insert 0.013 L/s 300 GPD for 6.57 L/s 150,000 GPD capacity and less; and 0.026 L/s 600 GPD for plants of more than 6.60 L/s 150,000 GPD capacity. For step aeration type, insert 0.026 L/s 600 GPD. For complete mixing type, insert 0.02 L/s 50 GPD.

NOTE: Delete reference to mechanical sludge collector for extended aeration type of 4.38 L/s 100,000 GPD capacity and less and for step aeration type of 3.0 L/s 67,500 GPD capacity and less.

NOTE: Delete reference to mixing with aeration tank contents for extended aeration type and step aeration type.

NOTE: Delete reference to mechanical aeration when step aeration type or complete mixing type is specified, or when not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

The Sewage Treatment Plant shall be capable of treating an average design flow of [_____] L/s gallons per day of domestic sewage, having a 5 day (BOD) loading of [_____] milligrams/liter (mg/l) and total suspended solids of [_____] mg/l. The raw sewage shall first pass through a [comminutor] [screening basket] [and an influent distribution channel] into an aeration tank of adequate capacity to provide [not less than [_____] hours detention time and] a maximum organic loading not to exceed [_____] kg per 1000 cubic meter [_____] pounds 5 day BOD per 1,000 cubic feet of aeration tank volume at average design flow rate. Sewage shall then pass on to a settling tank of adequate capacity to provide [not less than [_____] hours detention time and] a surface settling rate not to exceed [_____] L/s per square meter GPD per square foot at average design flow rate. The settled sludge shall [be collected by a mechanical sludge collector and] be recirculated back to the aeration tank [where it is to be rapidly and thoroughly mixed in with the aeration tank contents,] or wasted to the aerobic digester. The effluent from the settling tank shall be discharged to a chlorine contact tank of adequate capacity to provide a detention time of not less than 15 minutes at peak flow and then to outfall. The aerobic digester shall have a capacity of not less than 0.057 cubic meter 2 cubic feet per capita. Aeration shall be by diffused air [or mechanical aeration].

3.2 SLUDGE COLLECTION AND TRANSFER SYSTEM [AND RETURN SLUDGE MIXING]

NOTE: Delete wording within brackets, except for complete mixing type. On the project drawings, show:

1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).
2. Design flow.

3. 5-day BOD loading.
4. Suspended solids loading.
5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.
6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than 113.4 L 30 gallons is needed.
19. Size of hypochlorite solution tank if larger capacity than 208 L 55 gallons is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

[3.2.1 Sludge Transfer

NOTE: Delete wording within brackets, except for complete mixing type.

Sludge transfer shall be accomplished by one of the following methods:

- a. Separate pumps for return sludge and waste sludge with valved control on discharge side.

NOTE: Delete item (b) except for extended aeration type.

- [b. One pump with valved connections for return sludge and waste sludge.]

NOTE: Delete item (c) for complete mixing type.

- [c. One pump discharging to sludge division box for return sludge and waste sludge.]

NOTE: Delete item (d) in its entirety for step aeration type and for extended aeration type when eventual conversion to step aeration is contemplated; delete wordings in brackets within (d) for extended aeration type; retain item (d) in its entirety for complete mixing type.

- [d. Traveling pump discharging [directly into aeration tank and] into [waste sludge] trough with movable divider plate for proportioning return sludge and waste sludge.]

Discharge piping from sludge transfer pump(s) shall be not less than 75 mm 3 inches in diameter, flanged, and arranged to maintain a velocity of not less than 0.61 meters per second 2 feet per second when sludge pump(s) are operating at normal rates. Valves on return sludge and waste sludge piping on the downstream side of sludge transfer pumps shall be gate valves or plug valves. Materials for piping and valves shall be as specified in paragraph entitled "Piping." Sludge division box or trough shall be as specified under paragraph entitled "Appurtenances and Accessories."

13.2.2 Return Sludge Mixing

NOTE: Delete paragraph except for complete mixing type.

A positive means shall be provided for the thorough and rapid mixing of return sludge with aeration tank contents. One of the following means shall be provided:

- a. The return sludge shall be mixed by a mixer in a mixing chamber prior to entering the aeration tank influent distribution channel; mixer shall be as specified under paragraph entitled "Appurtenances and Accessories."
- b. The return sludge shall be discharged directly into the aeration tank

from a traveling pump traversing almost the full length of the aeration tank.

3.2.3 Scum Collection and Transfer

3.2.3.1 Scum Collection in Hopper Bottom Settling Tanks

NOTE: Delete the paragraph for extended aeration type above 4.38 L/s 100,000 GPD capacity, step aeration type above 2.96 L/s 20,000 GPD and for all sizes for complete mixing type. For plants below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for settling tanks. For plants above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in settling tanks. For plants between 0.66 and 4.38 L/s 5,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option. However, of the various types of mechanical sludge collectors, rotating sludge collectors appear to be available for plants of 1.31 L/s 30,000 GPD and above; chain-and-flight, 1.75 L/s 40,000 GPD and above; traveling reciprocating type, 0.66 L/s 15,000 GPD and above.

Scum collection shall be accomplished by means of a suction skimmer. Suction skimmer shall be a 50 mm 2 inch diameter drop pipe supported by a structural steel member and so mounted that it can be raised or lowered with respect to the liquid surface by means of stainless steel adjusting screws with hand knobs or by corrosion-resisting turnbuckles located above the liquid surface. Lower end of drop pipe shall be attached to a 50 mm 2 inch air lift by means of a flexible hose of chloroprene or other material suitable for use in sewage.

3.2.3.2 Scum Collection in Circular Settling Tanks

NOTE: Delete paragraph for extended aeration type below 1.31 L/s 30,000 GPD capacity.

Scum Collection in Circular Setting Tanks With Mechanical Sludge Collectors: Scum collector assembly shall include a blade skimmer and a scum trough. Assembly shall continuously move surface scum to the scum trough. The assembly shall discharge scum with a minimum discharge of water. Blade skimmer shall include an arm fabricated of structural steel shapes to which is attached a steel blade skimmer or floating redwood skimmer, with adjustable chloroprene wiper. Scum skimmer shall be supported by center shaft and one scraper arm. Scum trough shall be welded structural steel, minimum thickness 6 mm 1/4 inch, shall have connection to the scum airlift pump, and shall be supported from the tank wall or scum baffles. The inclined approach ramp leading to the scum trough shall be shaped to contain the scum as it is moved up the incline to the trough by the scum skimmer.

3.2.3.3 Scum Collection in Rectangular Settling Tanks

NOTE: Delete paragraph for extended aeration type below 6.57 L/s 150,000 PGD capacity and all step aeration type and extended aeration type when eventual conversion to step aeration type is contemplated.

Scum Collection in Rectangular Setting Tanks With Mechanical Sludge Collectors: Scum collection shall be accomplished by means of traveling blade or paddle skimmer or by suction skimmer. Traveling blade or paddle skimmer shall be attached to the traveling sludge collector at surface level and shall be designed to sweep the surface of the settling tank in one direction only with each pass of the sludge collector. Collected scum shall be discharged into a trough, collector pipe or suction skimmer. Scum trough shall be steel, 6 mm 1/4 inch minimum thickness, with approach ramp and shall have a connection to the scum air lift pipe and shall be supported from the tank wall. Collector pipe shall be steel pipe with a 1.05 rad 60 degree wide slot cut symmetrically above the vertical axis. At maximum intervals of 750 mm 30 inches, a 50 mm 2 inch wide band of full circumference shall be left for stiffness. End supports shall include a rolled steel collar welded to an adjustable steel end plate. A readily renewable grease-resistant, watertight seal shall be provided and so constructed that it will allow smooth action of the revolving pipe. Seal shall be readily renewable without removing pipe. End supports shall be secured to the concrete walls by stainless steel anchor bolts having a minimum diameter of 16 mm 5/8 inch. Collector pipe operator shall be manual, lever type mounted on the collector pipe. Operator shall be steel pipe having a minimum diameter of 31 mm 1 1/4 inches and shall be secured to the collector pipe with a bolted connection. Operator shall extend at least 900 mm 3 feet above the top of tank and shall permit rotation of the collector pipe at least 0.52 rad 30 degrees each side of the vertical axis. Collector pipe shall have suitable means of discharge to the scum airlift pump.

3.2.3.4 Scum Transfer

NOTE: Delete requirement for solenoid valve when automatic operation is not required. Automatic operation is to preferred especially in plants where minimal operator attendance would be anticipated.

Scum transfer shall be accomplished by means of an airlift pump and piping to the aeration tank. Airlift pump shall be as specified in paragraph entitled "Sludge Transfer Pump(s)," except that it shall be 50 mm 2 inch size. [A percentage-timer-controlled solenoid valve with valved bypass shall be provided on the airlift pump air supply.] Materials for piping shall be as specified in paragraph entitled "Piping."

3.2.4 Supernatant Transfer

When a pump is used for supernatant transfer from the aerobic digester tank to the aeration tank, the pump shall be an airlift pump as specified in paragraph entitled "Sludge Transfer Pump(s)," except that it shall be 50 mm 2 inch size. A shear gate or other positive means of flow regulation shall

be provided. All necessary piping shall be provided. Materials for piping and valves shall be as specified in paragraph entitled "Piping."

3.3 AIR BLOWER ASSEMBLY

Air blower assembly shall include air blower, blower driver, V-belt drive (for positive displacement blower), housing and accessories.

3.3.1 Air Blower

Air blower shall have the capacity to produce the plant air requirement at the necessary operating pressure including allowance for pressure drop in air piping, fittings, and accessories. Operating speed and size of blower driver shall be commensurate with capacity of blower. Not less than two blowers shall be provided. When two blowers are provided, each should have the capacity to provide the total plant air requirement. When more than two blowers are provided, they shall be in such capacities as to produce the total plant air requirement with the single largest air blower out of service. The air blower shall be the rotary positive displacement, single-stage centrifugal or multi-stage centrifugal type. Means shall be provided for adjusting the output of the blower. The blower shall be equipped with heavy-duty anti-friction bearings. Impeller(s), except when cast integrally with the shaft, shall be made of close-grained cast iron conforming to Class 35 of [ASTM A 48/A 48M](#), ductile iron conforming to [ASTM A 395/A 395M](#) or [ASTM A 536](#) or welded alloy steel conforming to [ASTM A 108](#). Impeller(s) shall have strong internal ribbing, shall be machined on exterior surfaces, and shall be dynamically balanced. Shaft(s) shall be machined and, except when cast integrally with the impeller, shall be made of steel conforming to [ASTM A 108](#). When shaft and impeller are cast integrally, the casting shall be of ductile iron conforming to [ASTM A 536](#). When shaft and impeller are cast separate pieces, impeller shall be either press fitted onto the shaft and held by means of a Woodruff key and lock nut, or the impeller shall be mounted on the shaft with a reverse threaded connection. The casing shall be cast iron conforming to [ASTM A 48/A 48M](#), Class 30. The rotary displacement type blower shall have two timing gears machined from heat-treated steel to synchronize the impellers accurately to maintain maximum rotational efficiency. The following AGMA standards for surface durability, strength and materials for spur gearing and helical gearing, as applicable, shall govern:

Spur gearing and helical gearing: [ANSI/AGMA 6113](#), [ANSI/AGMA 6013](#), [ANSI/AGMA 2011](#), [AGMA 908](#), [ANSI/AGMA 2001](#), [ANSI/AGMA 2004](#).

Gears shall be enclosed in an oil-tight housing and shall be lubricated by a splash oiling system from oil contained in the gear housing or pressure lubricated with integrally driven oil system. Blower shall be equipped with a Kingsbury type thrust bearing on the drive shaft so that thrust from the driver will not be transmitted to the blower impellers. The blower shall have an operating sound pressure level not to exceed 90-decibels over a frequency range of 37.5 to 9,600 cycles per second measured at [1.5 m 5 feet](#) from the unit. The manufacturer shall provide any silencing on the blower needed to meet this requirement.

3.3.1.1 Bearing

The bearings for positive displacement type blowers shall have a minimum rated life expectancy (L-10) of 50,000 hours, and for centrifugal type blowers, 30,000 hours, based on the [ABMA SBRB](#) Standards. Internal bearings shall be splash lubricated from the gear housing oil reservoir. Drive-end

bearings shall be grease lubricated through grease fittings in each bearing housing located so that they are easily accessible. Grease vents shall be provided in the bearing housing to prevent rupture of grease seals due to overgreasing. Air vents shall be provided between the seals and the impeller chamber to relieve excessive pressure on the seals.

3.3.1.2 Couplings for Centrifugal Blowers

The couplings shall be self-aligning forged steel gear type having two identical hubs; two identical sleeves, a flanged gasket, a set of flange bolts, nuts, and lockwashers, and four lubrication plugs with copper gaskets. Torque shall be transmitted through the mating gear teeth of the hubs and sleeves.

3.3.2 Blower Driver

NOTE: Insert electrical power characteristics.

Positive displacement type blower shall be driven by an electric motor through a V-belt drive. Centrifugal type blower shall be driven by a direct-connected motor through a flexible coupling. Maximum speed of centrifugal type blowers shall be 3600 rpm. Motor shall be constant speed, totally enclosed, fan-cooled horizontal type, suitable for outdoor service, and conforming to NEMA MG 1. The motor shall be of adequate wattage horsepower to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [_____] volt, [_____] phase, [_____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. If induction type, motor shall have NEMA Class B insulation, normal starting torque, low starting torque, low starting current. If synchronous, it shall operate on unity power factor or 0.8 power factor. Excitation shall be by direct-connected exciter. The electric motor shall have an operating sound pressure level not to exceed 90 decibels over a frequency range of 37.5 to 9,600 cycles per second measured at 1.5 m 5 feet from the unit. The manufacturer shall provide any silencing of the motor needed to meet this requirement.

3.3.3 V-belt Drive for Positive Displacement Type Blower

V-belt drive shall be designed to produce a blower speed not greater than the following:

Blower Size (mm)	Maximum Speed (Rpm)
50	3,500
75	2,750
100	2,400
125	1,900
150	1,600
175	1,370
200	1,200

Blower Size (Inches)	Maximum Speed (Rpm)
2	3,500
3	2,750
4	2,400
5	1,900
6	1,600
7	1,370
8	1,200

The V-belt drive shall include blower sheave, motor sheave, and V-belt. Sheaves shall be cast steel and keyed to the shaft. Multiple belts shall be used when necessary to transmit the required power. V-belt shall be of a heavy-duty type, oil and heat resistant, and static dissipating. Drive shall be designed to have minimum service factor of 1.5. Spare sheaves shall be furnished to allow alternative operation at 75 percent of total plant air requirements.

3.3.4 Air Blower and Blower Driver Housing

The blower-driver combination shall be mounted on a base plate with spring-type vibration isolators in a weatherproof housing or equivalent protective enclosure. The weatherproof housing shall be constructed of not less than 1.5 mm 16 gage steel supported by the necessary structural members to obtain rigidity. The housing shall provide easy access to enclosed equipment through access doors, or the housing shall be large enough to accommodate the above equipment with reasonable allowance for servicing and adjustment of equipment. Doors shall be equipped with locking devices. For proper air ventilation, air louvers shall be placed with the enclosure on the blower and driver chamber side. When air filter is to be placed in the housing it shall have louvers of adequate area for both ventilation air and blower intake air movement. Base plate shall be of welded steel or cast iron sized to carry the blower-driver combination and shall have sufficient rigidity to maintain alignment between elements, and shall be insulated against vibration. Base plate shall have provisions for adjustment of V-belt tension, and shall be provided with necessary anchor lugs for foundation bolts and lifting brackets. Housing shall be designed for mounting either on the plate or on a concrete pad adjacent to the plant.

3.3.5 Air Blower Accessories

3.3.5.1 Air Filter and Air Filter Gage

The air filter shall be of the filter-silencer type having a maximum pressure loss of 25 mm 1.0 inch water gage mm In.W.G. at maximum capacity of blower when clean. The silencing chamber shall have peak attenuation in the frequency range 300-1, 1,200 cycles per second. The filter media shall be composed of several layers of crimped zinc-coated wire mesh. Filter shall be of the viscous type, coated with an adhesive, or dry type. The filtered air shall have a dirt concentration of not more than 0.5 mg per 28.4 cubic meters 0.5 milligram per 1,000 cubic feet of air at 748 mm 29.92 inches of mercury and 0 degrees C32 degrees F. The air filter gage shall be provided for measuring resistance in mm In.W.G. to air flow through the air filter. The gage shall be of the inclined tube differential type equipped with three-way angle type valve for venting to atmosphere. The case shall be of corrosion resisting material and shall have dial with gradations. It

shall be provided with necessary lengths of 6 m 1/4 inch copper or aluminum tubing, two static pressure taps, two toggle bolt mounting assemblies, and two additional bottles of red gage oil.

3.3.5.2 Butterfly Valve

Butterfly valve and operators shall conform to AWWA C504, except as modified herein, and shall have rubber seats which are recess-mounted and clamped into the valve body. Each valve shall be shop-tested for leakage with the disc in the horizontal plane, with zero pressure downstream, and with an upstream gage pressure of 345 kPa 50 psig, all in accordance with testing requirements of AWWA C504 for butterfly valves. The upper surface of the disc shall be visible and covered with a pool of water. Air pressure as stated shall be applied to the lower face of the closed disc for a period of 5 minutes, during which period there shall be no indication of leakage past the valve disc as revealed in the form of bubbles in the water pool on top of the disc. Valve operator shall be hand-wheel, lever, or chain operated.

- a. Valve Body: Valve body shall be constructed of close-grained cast iron conforming to ASTM A 126, Class B, with integrally cast hubs for shaft bearing housing of the through boss-type. Permanently self-lubricating body bushings shall be provided and shall be sized to withstand bearing loads. A stuffing box of liberal dimensions shall be provided at the operator end of the vane shaft, arranged so that the packing can be replaced by removing the bronze follower without removing the operator.
- b. Discs: Discs shall be positively secured to the shaft with keys and/or pins of Type 316 stainless steel. Seating edge of the disc shall contact the seat in the body for full 6.28 rad 360 degrees without penetration of the seating surface by the shaft. Discs for valves with rubber seat mounted in the body shall be of a symmetrical one-piece cast design of alloy cast-iron (14 percent nickel, 6 percent copper, 2 1/2 percent chromium) with no external ribs. Discs for valves with rubber seat mounted on the disc shall be cast iron conforming to Class 40.
- c. Valve Shaft: Valve shaft shall be of Type 304 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic or seating torque.

3.3.5.3 Pressure Relief and Unloading Valve

A pressure relief and unloading valve shall be provided for each positive displacement blower in the air piping on the discharge side and shall perform the dual function of pressure relief and unloading the blower for start-up. The valve shall have a cast-iron body with integral valve seat, cast-iron disc, and steel spring for pressure setting. Valve shall be furnished for a pressure setting of not more than 10 percent above maximum operating pressure, but shall also have an operating nut or wheel for field adjustment of pressure setting. Pipe connection shall be flanged or screwed.

3.3.5.4 Check Valve

Check valve shall be provided on the discharge side of each blower and shall have a cast-iron or steel body, a single steel or aluminum swinging disc, or dual discs. Dual disc valves shall have acrylonitrile-butadiene rubber seals on the seating surface. Piping connection shall be flanged.

Valve shall be suitable for use in the maximum operating pressure range and shall have a maximum pressure loss of 0 kPa 0.0 psi at maximum blower capacity.

3.3.5.5 Snubber

Air inlet to blower shall be provided with a snubber in order to reduce any vibration of the blower being transmitted to the air filter. Pressure drop across each snubber shall not exceed 3.45 kPa 0.5 psi at maximum blower capacity.

3.3.5.6 Expansion Joints

Expansion joints shall be of the rubber spool type made of duck and chloroprene with a single arch in the middle, reinforced with steel wire rings, flanged and fitted with zinc-coated split retaining rings. Expansion joints shall be suitable for use with pressures up to 103.4 kPa 15 psig and temperatures up to 135 degrees C 275 degrees F. Expansion joints shall be provided in the air piping system at the inlet and outlet of the air blower.

3.3.5.7 Pressure Gage

Pressure gage in the air blower discharge piping shall be of the Bourdon spring type, with corrosion-resisting movements. Cases shall be finished in baked enamel. Gages shall be provided with shut-off cocks or valves and shall have an operating range of 0-103.4 kPa 0-15 psi.

3.3.5.8 Thermometer

Thermometer shall be straight form or dial type. Thermometer shall have brass or stainless steel case. Thermometer shall be moisture-proof, dust-proof, shock proof, and vibration-proof. Thermometer shall have a stainless steel temperature sensing bulb not less than 50 mm 2 inches long, with 13 or 19 mm 1/2 or 3/4 inch male pipe thread connection. Thermometer shall read to a maximum temperature of 20 percent above maximum operating temperature.

3.3.5.9 Guards

Belts, sheaves, couplings, projecting setscrews, keys, and other rotating parts, located so that any person may come in close proximity thereto, shall be fully enclosed or properly guarded in accordance with ASME B15.1.

3.4 FROTH CONTROL SYSTEM

3.4.1 General

The froth control system shall include pump, piping spray nozzles, valves, and discharge strainer. The pump shall pump clarified effluent from the upper part of the settling tank to the spray nozzles in the settling tank. A strainer shall be located on the discharge side adjacent to the pump. A hose bibb easily accessible from the walkway shall be provided in a branch from the froth control system main line piping. A gate valve shall be provided in the froth control system main line piping immediately adjacent to the hose bibb branch on the downstream side.

3.4.2 Froth Control System Pump

Pump shall be a submersible pump or a centrifugal pump. Pump shall have a

capacity of furnishing approximately 0.13 L/s 2 gpm to each spray nozzle at the necessary spray nozzle pressure to produce the desired spray pattern. Pump shall be mounted in a fabricated steel well accessible from the top of the top of the tank. A brass screen or strainer shall be provided on the suction side of the pump.

3.4.2.1 Submersible Pump

The pump shall be of the self-priming, single-stage, single-suction, centrifugal type and shall include casing, impeller seal and motor. Pump and motor shall be in a common sealed casing and designed to be completely submersible. The pump shall be oil-filled using the manufacturer's standard lubricant to dissipate heat, lubricate bearings permanently, and eliminate potentially moist air within the motor chamber. Pump shall be manually controlled from the electrical control panel and shall be provided with a three-conductor waterproof power cord of sufficient length.

- a. Pump: The impeller shaft shall be an extension of the motor shaft. Casing shall be cast iron, ASTM A 48/A 48M, Class 25 minimum, or ASTM A 126, Class B minimum. The casing shall be equipped with a priming port and means for readily draining the casing. The pump shall have removable wearing surfaces and bolted plates or segmented sections. Impeller shall be bronze, ASTM B 62. Impellers shall be cast in one piece, shall be balanced, and shall be keyed, threaded, or press fit to the motor shaft in a manner to provide positive locking against any rotative loosening effect. Shaft shall be corrosion-resisting steel, ASTM A 276, Type 416, or other corrosion resisting steel equal or better than the foregoing. The impeller and motor shall have a common shaft. Shaft seal shall be mechanical type. The motor shall be provided with antifriction lubricated-for-life, sealed bearings. The bearings shall function on a continuous-duty basis while supporting the maximum combined radial and thrust loads imposed by the elements and hydraulic action of the pump.

NOTE: Insert electrical power characteristics.

- b. Pump Motor: Motor shall be constant speed, totally enclosed, vertical type, conforming to NEMA MG 1. The motor shall be of adequate wattage horsepower to drive the pump continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [____] volt, [____] phase, [____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage.

3.4.2.2 Centrifugal Pump

Pump shall be vertical centrifugal motor driven type and shall include casing, impeller, pump shaft, suspension pipe, discharge pipe, cover plate, and motor. The pump shall be connected to the motor by a vertical shaft with a flexible coupling, or by a thrust-carrying solid shaft motor with a rigid coupling, or the connection may be made by use of a thrust-carrying hollow shaft motor. Pump shall be manually controlled from the electrical control panel.

- a. Pump: Casing shall be cast iron, ASTM A 48/A 48M, Class 25 minimum, or ASTM A 126, Class B, minimum. Impeller shall be bronze, ASTM B 62 or

ASTM B 584. The impeller shall have ample water passages, be mechanically balanced, and keyed and locked or otherwise securely fastened to the pump shaft to prevent backing-off or loosening with change of rotation. The mechanical properties and diameter of the shaft shall be such as to insure that neither whip, deflection, nor vibration will be of such magnitude under normal operating conditions to impose loads on the shaft bearings greater than the design loads. Means shall be provided on that part of the shaft extending above the cover plate for adjustment of the clearance between the impeller and the inner surfaces of the volute section. Suspension pipe shall be of heavy wrought steel tubing or cast iron pipe and shall have ample strength and rigidity. Suspension pipe flanges shall be suitably machined or doweled to insure proper alignment of the pump and shaft. Discharge pipe shall be of wrought steel having a wall thickness not less than that specified in **ASTM A 53/A 53M** for schedule 40 pipe. The discharge end of the pipe shall terminate in a threaded connection of pipe size in accordance with the manufacturer's standard practice. The sump cover plate shall be cast iron or steel. One or more radial ball bearings designed and located to carry mechanical and hydraulic thrust loads of rotating components shall be furnished. Thrust bearings shall be located above the pump-mounting plate or cover and fitted with a moisture-proof seal. Intermediate shaft and lower bearings shall be of the sleeve type. Sleeve type bearings shall be heavy-duty bronze, carbon, or molded plastic-lined. Lubrication fittings shall be located in accessible, protected positions. A bright red mark shall be painted at each lubricating point.

NOTE: Insert electrical power characteristics.

- b. Motor: Motor shall be constant speed, totally enclosed, vertical type, suitable for outdoor service, and conforming to **NEMA MG 1**. The motor shall be of adequate **wattage horsepower** to drive the equipment continuously at the maximum load encountered under any operating conditions without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [____] volts, [____] phase, [____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. The motor shall be mounted on a steel or cast iron stand of substantial construction to ensure correct alignment of motor and pump.

3.4.3 Spray Nozzles

Spray nozzles shall be of the self-cleaning, hinged, counterweighted type that will produce a sharp flat spray at normal pumping rates. The spray nozzle shall be of non-clog and non-freeze design and have a minimum orifice of **6 mm 1/4 inch** diameter. Spray nozzles shall be self-cleaning, and shall be made of corrosion-resisting materials and shall be adjustable both vertically and horizontally.

3.4.4 Discharge Strainer

Strainer shall be Y-pattern of suitable size mesh to prevent clogging of the spray nozzles. Strainer shall be of brass or stainless steel and shall be accessible for cleaning from the walkway.

3.4.5 Piping and Valves

Materials for piping and valves shall be as specified in paragraph entitled "Piping." Hose bibb shall be of brass with 19 mm 3/4 inch hose thread connection. Union shall be provided adjacent to valves.

3.5 HYPOCHLORINATOR ASSEMBLY

NOTE: Delete this paragraph and subparagraphs thereto when hypochlorinator is not required. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 and 6.57 L/s 100,000 and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

3.5.1 General

NOTE: Delete reference to heater for plants in areas where freezing temperatures are not encountered.

Hypochlorinator shall pump hypochlorite solution from the solution tank through tubing to the diffuser located in the chlorine contact tank. Hypochlorinator assembly shall include feed pump with motor, hypochlorite mixing tank, hypochlorite solution tank, timer, [heater,] suction and discharge tubing, diffuser, and housing. Hypochlorinator assembly shall be readily accessible and located adjacent to the chlorine contact tank.

3.5.2 Hypochlorinator

NOTE: Insert average daily flow in first blank and maximum 24 hour flow in second blank. See NAVFAC DM-5, Figure 10-1.

The hypochlorinator shall be a solution feed pump of positive displacement type designed for feeding sodium or calcium hypochlorite solutions. Hypochlorinator shall have a capacity to provide an adjustable dosage rate of not less than 2 to 8 mg/l of chlorine equivalent over a flow range from [_____] to [_____] L/s [_____] to [_____] gpd. Hypochlorinator shall be fully automatic and manually adjustable. Hypochlorinator shall have diaphragm type or peristaltic type pump.

3.5.2.1 Diaphragm Type

The head of the pump shall be of corrosion-resisting plastic material that will not react with the hypochlorite solution. The diaphragm of the feeder shall be chemical resistant material or chloroprene synthetic elastomer. Foot valve and strainer shall be provided where necessary.

3.5.2.2 Peristaltic Type

Pump shall be of the direct-feed tube type. All parts that which come in contact with the hypochlorite solution shall be chemically resistant plastic or synthetic rubber.

3.5.2.3 Motor

NOTE: Insert electrical power characteristics.

Motor shall be constant speed, totally enclosed, horizontal type, suitable for outdoor service, and conforming to **NEMA MG 1**. The motor shall be of adequate **wattage horsepower** to drive the feed pump continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [_____] volt, [_____] phase, [_____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. Motor shall be either direct-connected to pump or provided with V-belt drive.

3.5.3 Accessories

NOTE: Use 113.4 L 30 gallon mixing tank capacity unless larger tank is necessary.

NOTE: Use 189 or 208 L 50 or 55 gallon solution tank capacity unless larger tank is necessary.

NOTE: Delete requirements for heating for plants in areas where freezing temperatures are not encountered.

Solution and mixing tanks and covers shall be of polyethylene plastic or fiberglass with foam insulation. Solution mixing tank shall have electric motor-driven mixer with stainless steel shaft and impeller; capacity shall be [113.4 L] [[_____] L] [30 gallons] [[_____] gallons]. Hypochlorite solution tank shall have a capacity of [189 L or 208 L] [[_____] L] [50 gallons or 55 gallons] [[_____] gallons]. Suction, discharge, and siphon tubing shall be of translucent polyethylene plastic or nylon reinforced plastic capable of withstanding 1034 kPa 150 psi internal pressure at 54.5 degrees C 130 degrees F. Diffuser shall be located at the inlet to the chlorine contact tank and shall be of rigid PVC or ABS pipe resistant to chlorine solution. The diffuser shall be perforated and of the open channel type and shall be fastened at each end to the tank wall near the bottom, in the flow stream of the influent to the chlorine contact tank. Control of hypochlorinator shall be by means of liquid level sensing probes located in chlorine contact tank. The hypochlorinator assembly shall be housed in a reinforced fiberglass or metal housing of at least 0.9 mm 20 gage metal and lined with 25 mm one inch minimum thickness insulation. Housing shall have a removable cover for easy access. [Tape heater or thermostatically controlled heat lamps or other method of space heating

shall be provided].

3.6 CHLORINATOR ASSEMBLY

NOTE: Delete this paragraph and subparagraphs thereto when chlorinator is not required. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 and 6.57 L/s 100,000 and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

3.6.1 General

Chlorinator shall receive chlorine gas from chlorine cylinders and water from the water supply system and discharge chlorine solution through piping to the diffuser located in the chlorine contact tank. Chlorinator assembly shall include chlorinator, scale, chlorine gas manifold, flexible connector, water piping, chlorine solution piping, vent tubing, vacuum signal tubing, diffuser, and housing.

3.6.2 Chlorinator

Chlorinator shall be solution feed vacuum-type and comprise the following parts: a pressure-regulating or vacuum-regulating valve, a flowmeter, a vacuum relief or vacuum shut-off valve, a pressure relief valve, a check valve, an injector or ejector, a gas filter, a chlorine pressure gage, a chlorine supply indicator, water pressure gage, a water strainer and an electric heater. The chlorinator shall be designed for proportional-automatic control. Chlorinator shall be so designed that the control mechanism is under a vacuum when the unit is in operation. The gas shall be thoroughly mixed with water before it is discharged from the injector. The chlorinator shall function accurately within four percent of the set feed rate regardless of normal variations in the water pressure operating the machine. In case of failure of the gas supply, the chlorinator shall be protected against flooding by a ball check valve or similar device and under no condition shall it be possible for water or water vapor to enter into any dry gas lines or control parts. Chlorinator shall have a capacity to provide a dosage rate of not less than 2 to 8 mg/l over a flow range from [_____] to [_____] L/s gpd. All component parts of the chlorinator exposed to chlorine gas or chlorine solution shall be of materials resistant to chlorine. The pressure-reducing or vacuum-regulating valve shall reduce the pressure of the chlorine gas to a vacuum and maintain a constant flow within plus or minus 4 percent for any given setting of rate of feed. The vacuum and pressure relief device shall limit the vacuum within the chlorine feeding-machine and provide a suitable vent to the outside atmosphere for the escape of any chlorine gas release through improper operation of the equipment. A vacuum shut-off valve may be substituted for the vacuum relief which will seal off the chlorinator when excessive vacuum is present. The flowmeter shall be a metering device for measuring the flow of chlorine gas in pounds per 24 hours over a range of not less than 10 to 1 maximum feed and shall be mounted on the face of the chlorinator. The injector or ejector shall receive all chlorine and make-up water and discharge the resulting solution to the point of an

application. A check valve that will prevent water backing into the injector suction line shall be provided. The vacuum regulator valve shall automatically close when ejector water supply or ejector vacuum is lost. Chlorine pressure gage shall be of the diaphragm type, and shall be made of corrosion-resisting material. The gage shall indicate accurately the pressure of chlorine gas as supplied from the cylinder. Chlorine supply indicator shall be supplied with the unit to show whether chlorine is available or exhausted. The proportional-automatic control device shall be actuated by a pressure differential or a signal from the primary element and shall be so transmitted or converted as to vary the rate of chlorine feed in proportion to the rate of flow over the entire range of the chlorine meter in the chlorine feeding machine. The equipment shall be actuated by the flowmeter. Chlorinator shall be floor, panel- or wall-mounted. Floor-mounted and panel-mounted units shall have necessary components enclosed in a panel or cabinet and shall be self-supporting. Wall-mounted unit shall contain all necessary components and shall be capable of firm attachment to a wall or partition.

3.7 COMMINUTOR AND BAR SCREEN UNIT

NOTE: Delete paragraph and subparagraphs when comminutor is not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

3.7.1 General

The comminutor and bar screen assembly shall be complete and self-contained and so arranged that whenever the comminutor is not operating, all sewage shall be diverted automatically through the bar screen before it enters the plant, and whenever the comminutor is operating, all sewage is directed through the comminutor.

3.7.2 Comminutor

NOTE: Insert flow rates as derived from NAVFAC DM-5, Figure 10-1.

The comminutor shall be rotating type and shall include a rotating slotted drum that functions as a screen and a support for the rotating cutters, a casing that supports the stationary cutters, and a drive assembly. The rotating cutting teeth shall be evenly spaced around the entire outer perimeter of the rotating drum. As the drum rotates, the cutting teeth shall pass through a stationary comb section and cut against it. The cutting and screening mechanism shall cut or shred all sewage solid, including sticks, rags, and stringy materials, without removing them from the sewage flow, without clogging the screen, and without binding, jamming, or stalling the moving parts. The comminutor shall be readily removable from its housing without disturbing plant operation. The rotating drum and

the support casting shall be of high-quality close-grained cast iron or cast aluminum of adequate strength and rigidity to withstand all loads imposed in them from the operation of the comminutor and drive assembly. Cast iron shall meet the requirements of **ASTM A 48/A 48M**, Class 30, minimum. Aluminum shall be a heat-treated aluminum alloy. Casing may be composed of one or more parts. The comminutor shall reduce the solids in sewage to a size that will pass through **6 mm 1/4 inch** slots in the rotating drum. The comminutor shall operate automatically and continuously, it shall be designed to pass a minimum flow of [_____] **L/s GPD**, an average flow of [_____] **L/s GPD**, and maximum flow of [_____] **L/s GPD**, and shall be capable of satisfactory operation at zero flow conditions. Comminutor shall be designed for free discharge where the discharge is located above the liquid level in the aeration tank or controlled discharge when the drum is partially submerged.

3.7.2.1 Comminutor Drive

NOTE: Insert electrical power characteristics.

Comminutor shall be driven by an electric motor, constant speed, totally enclosed, horizontal or vertical type, suitable for outdoor service, and conforming to **NEMA MG 1**. The motor shall be of adequate **attage horsepower** to drive the comminutor continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor shall be suitable for operation on [_____] volt, [_____] phase, [_____] Hertz service. Motor shall be protected against overload, low voltage, and unbalanced voltage. Power transmission from motor to rotating element shall be by means of a vertical or a right angle gear reduction unit provided as an integral part of the motor. Reduction ratio shall be such as to produce the proper operating speed for the comminutor mechanism. The unit shall be designed to withstand any loadings produced by thrust, out-of-balance, and vibration resulting from operating conditions and shall operate from zero rpm to a speed compatible with the drum shaft speed. All components shall be designed to withstand continuously the full load motor **wattage horsepower**. Gearing may be spur, helical, spiral, bevel, worm or a combination thereof. All gears shall be wrought or alloy steel except that worm gears shall be bronze. The gear teeth may be through-hardened, contour-induction-hardened, nitrided, or carburized. Flame-hardened gears will not be acceptable. The housing shall be of high-quality, close-grained cast-iron or fabricated steel. A lubrication system shall be provided for the gears. Bearings may be lubricated with oil or grease. The comminutor electric circuitry shall include an automatic overload type reversing device with momentary time delay to prevent jamming or damage to the unit should an exceptionally hard object be encountered in the sewage. The gear motor shall be mounted on the comminutor in a close coupled arrangement.

3.7.2.2 Cutting Elements

All cutting elements, including combs, teeth and bars, shall be of stellite, Type 316 hardened stainless steel, or high-carbon chrome steel. Elements shall be completely adjustable to allow them to be readjusted to compensate for wear. Elements shall be removable for sharpening or replacement.

3.7.2.3 Bearings

All bearings shall be of the antifriction type having a rated-life expectancy (L-10) of 100,000 hours based on ABMA SBRB Standards when operating continuously at the rated full load wattage horsepower and speed.

3.7.2.4 Lubrication

Bearings shall be either oil or grease lubricated. Gear reduction unit shall be oil or grease lubricated. Oil lubricated bearings and reduction units shall have sight glass or other positive means of determining oil level. All grease-lubrication pressure-line fittings and all oil fill and drain lines shall be easily accessible when comminutor is in place.

3.7.2.5 Anchorage

Comminutor shall be furnished complete with Type 316 stainless steel anchor bolts and cast iron soleplate or suitable support bracket for installation within the box channel or trough.

3.7.3 Bar Screen

The bar screen shall be constructed of 6 mm 1/4 inch by 50 mm 2 inch flat steel bars, with the 50 mm 2 inch faces parallel with sewage flow, or 13 mm 1/2 inch diameter steel bars hot-dipped after fabrication, with 25 mm one inch space between bars.

3.7.4 Comminutor Chamber

NOTE: Delete "or concrete" when steel plant only is required. This specification is structured for steel plant only, concrete plant only, or steel or concrete plant at the Contractor's option. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life. Steel plant is generally more economical in first cost than concrete plant; however, maintenance costs may be higher. Concrete plant would have a higher life expectancy in highly corrosive soils. Small steel plants are suitable for relocation. Concrete plant is considered as plant having outer walls of concrete regardless of material used for interior walls or partitions. Steel plants are considered as plants having outer walls of steel and bottom of steel or concrete (except that all-steel would be needed for relocatable plants).

Chamber shall be of steel [or concrete]. Steel chamber shall be constructed of 6 mm 1/4 inch steel plate, with necessary angle iron on top edges and having not less than 200 mm 8 inch flanged inlet and 200 mm 8 inch flanged outlet. The chamber shall be fitted with diversion slide gate(s), comminutor inlet and discharge, anchor bolts, inclined or vertical bar screen, and contain a stop gate of steel or aluminum to stop flow to comminutor when it is out of service.

3.8 SCREENING BASKET

NOTE: Delete the paragraph when comminutor is required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

There shall be furnished and installed at the plant influent, a readily removable, fabricated steel screening basket, sized for maximum flow, which shall be located so that the total volume of incoming raw sewage will be screened before it enters the plant. The basket shall be fabricated from 5 mm 3/16 inch diameter 302 stainless steel wire or 10 mm 8 inch hot-rolled steel bars with 25 mm one inch space between bars.

3.9 INSTALLATION

3.9.1 General

Installation work shall include construction of the concrete support slab(s); setting and anchoring of the treatment plant; construction of concrete pads for equipment not mounted on the plant; field installation of plant equipment, accessories, and appurtenances shipped unmounted to the project site; installation of piping from blowers to air header, piping connections to plant inlet and outlet, and installation of water service line; and installation of electrical wiring from electrical control system enclosure to motors and installation of electrical service to the electrical control system enclosure. The installation work covered by this section also includes earthwork operations as interrelated to plant installation. Except as modified or amplified herein, sewage treatment plant shall be installed in accordance with the recommendations of the manufacturer of the plant.

3.9.2 Manufacturer's Representative

The Contractor shall procure the services of an engineer representative of the manufacturer of the major portion of the treatment plant who is also familiar with the other equipment furnished. The representative shall inspect the equipment after erection, make adjustments in placing the equipment in operation, and shall be present during final inspection, start-up, and acceptance test.

3.9.3 Sequence of Operations

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02, "Unified Facilities Guide Specifications (Ufgs) Format Standard".

NOTE: Delete "cathodic protection" when concrete

plant only is specified.

Sequence of operations shall, in general, follow the recommendations of the plant manufacturer. Installation of plant shall not begin until the concrete support slab has achieved not less than fifty percent of its maximum strength. Backfilling operations as specified in [_____] shall be modified as recommended by the instructions of the plant manufacturer. All welding, [cathodic protection] alignment, water tightness testing, painting, and anchoring shall be completed, inspected, and approved before any backfilling is done.

3.9.4 Matchmarking

All parts and components of the plant shall be clearly match marked, corresponding to assembly drawings furnished by the manufacturer of the plant.

3.9.5 Qualification of Welders

All welding shall be done by welders qualified and in accordance with AWS D1.1/D1.1M.

3.9.6 Piping

Piping shall be installed to true alignment and rigidly supported. Mechanical joints shall be made in accordance with the requirements of AWWA C600. Flanged joints shall be made up tight, care being taken to avoid undue strain on flanges, valves, fittings and other equipment and accessories. Screwed joints shall be made up tight with a stiff mixture of graphite and oil, inert filler and oil, or an approved graphite compound, applied to the male threads only. Threads shall be full cut; not more than three threads on the pipe shall remain exposed.

3.9.7 Settling Tank Floor

NOTE: Delete requirements for signal transmission to the chlorinator when hypochlorinator is specified. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 and 6.57 L/s 100,000 and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

When rotating sludge collector is used, work shall be as hereinbefore specified through placing of tank floor except for sludge cone, which shall be in accordance with recommendations of the plant manufacturer. The tank floor shall then be given a screed finish, after which it shall be roughened by scoring with a rake or similar tool. Following installation of the rotating sludge collector mechanism, the tank floor shall be brought to finish grade by means of a cement-mortar grout surfacing swept into place by use of the sludge collector arms, as hereinafter specified. When the collector mechanism has been erected and inspected by the engineer representative of the manufacturer and the arms and blades have been

adjusted to give the required clearance above final floor grade, a 50 by 150 mm 2 by 6 inch wooden straight-edge with metal-clad edge shall be fastened to each sweeping arm approximately 6 mm 1/4 inch below the sweeping blades to provide a suitable squeegee. Cement-mortar grout shall be composed of one part cement, three parts sand, with sufficient water as required for conditions of placement, and with one teaspoon of powdered aluminum added per bag of cement. Before the cement-mortar grout is placed, the floor shall be thoroughly cleaned of dirt, soil, or other substances that would prevent the proper bonding of the surfacing to the concrete subfloor. The grout surfacing shall be brought to finish grade as nearly as possible by hand. The collector arms with straightedges attached shall be rotated manually to complete the operation. Use of the drive unit for sweeping in the grout surfacing will not be permitted. Provision shall be made to prevent grout from entering the sludge cone; any grout which falls in the sludge cone or on the tank walls shall be removed immediately.

3.9.8 Repair Painting

All metal surfaces that require painting shall be inspected for holidays, scratches, chips or other damages. These imperfections shall be refinished by cleaning all burrs and rough surfaces and sanding to a smooth finish, after which the surfaces shall be primed and repainted.

3.9.9 Adjustments

For items of equipment involving V-belt drives, adjustment of sheave alignment and belt tension shall be carried out in accordance with product manufacturer's instructions as furnished by the plant manufacturer.

3.10 FIELD TESTS AND INSPECTIONS

3.10.1 General

The [Contracting Officer will] [Contractor Quality Control representative shall] conduct field inspections and witness field tests specified in this specification. The Contractor shall perform field tests and provide all labor, equipment and materials required for testing, except that the Government will provide water, fuel, and electric power required for field test, when available. All defective equipment, materials, or workmanship disclosed as a result of the tests given herein shall be corrected by the Contractor at no cost to the Government.

3.10.2 Alignment and Leveling

Inspection shall be made to assure that the plant is level within tolerances recommended by the plant manufacturer. All plant components and equipment shall be checked to ensure that they are properly aligned and level.

3.10.3 Plant Equipment

All mechanical and electrical units shall be operated and tested as specified herein. Should any defects that occur before or during the tests, shall be remedied and changes or replacement of equipment shall be made as may be necessary to comply with these specifications.

3.10.3.1 Comminutor Tests

NOTE: Delete the paragraph when comminutor is not required for plant. For plants of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration tank. For installations in which all sewage has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

The comminutor shall be operated with liquid flowing through the comminutor. After two hours of operation, overheating, noise, vibration, and speed of the motor and comminutor shall be checked. The automatic reversing of the comminutor shall be checked when an object is lodged in the cutting stream.

3.10.3.2 Mechanical Aerator Tests

NOTE: Delete paragraph when step aeration type or complete mixing type is specified or when mechanical aerator is not allowed for extended aeration type. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

Mechanical aerator(s) shall be tested as soon as practicable after installation, and the aeration tank is ready for use. The aerator shall be operated under the varying submergence conditions specified in the factory test. During these tests, the unit(s) shall operate without overheating or excessive vibration and shall be satisfactory in every respect. The initial operation of the aerator and the conduct of the field tests shall be under the supervision of the plant manufacturer. The Contractor shall supply such labor and materials as may be necessary to properly perform the tests. During the tests, operating data shall be taken at regular intervals and incorporated in a report. Data readings shall be based on plant meters, gages, and instruments, and shall include the following: motor amperes, motor kilowatts, bearing temperatures, and lubricating oil pressures and temperatures.

3.10.3.3 Blower-Driven Assembly Operation Tests

Blower-driven assembly shall be tested as soon as practicable after installation and the aeration tank is ready for use. The blower shall be operated under varying capacities and discharge pressures covering the range of conditions specified. During these tests, the units shall operate without overheating or excessive vibration. The initial operation of the blower driver and the conduct of the field tests shall be under the supervision of the plant manufacturer. The Contractor shall supply such labor and materials as may be necessary to properly perform the tests. During the tests, operating data shall be taken at regular interval and

incorporated in a report. Data readings shall be based on plant meters, gages and instruments, and shall include the following:

- a. Air volume
- b. Air inlet and discharge pressure and temperature
- c. Motor amperes
- d. Motor kilowatts
- e. Bearing temperatures
- f. Stator temperatures
- g. Lubricating oil pressures and temperatures
- h. Lubricating oil cooling water temperatures

3.10.3.4 Diffusers

Performance tests shall be conducted on the diffusers in the field.

a. **Oxygenation Capacity Tests:** Tests shall be performed as follows:

- (1) The aeration tank shall be thoroughly cleaned and then filled with fresh tap water.
- (2) The temperature of the fresh water shall be as close to **20 degrees C 68 degrees F** as possible.
- (3) Submersible sample pumps shall be installed at three operating depths, 2.4 m, 1.8 m, and 1.2 m **8 feet, 6 feet, and 4 feet** depths at two selected locations in the basin on opposite sides of the tank, one at 1/4 the distance from center of tank and the other at 3/4 the distance from center.
- (4) A catalyst, chloride or sulfate, shall be dissolved in the tank contents, with the diffusers working to insure mixing, to a minimum concentration of 2 mg/l of cobalt ion.
- (5) After the tank has reached a steady state condition for 30 minutes, a sodium sulfite solution, which removes the D.O. shall be released uniformly into the tank contents. For a liquid having an initial D.O. concentration of 10 ppm, approximately one pound of dry sodium sulfite shall be provided per **3,780 L 1,000 gallons** of liquid per test. (This will provide an excess of sodium sulfite to compensate for oxidation during mixing.)
- (6) As the D.O. rises in the tank, size samples, one for each depth at each location, shall be drawn at one to five minute intervals. Interval shall be selected to obtain at least six sets of samples between 10 and 90 percent saturation. The D.O. shall be run by the Azide Modification of the Iodometric Method as outlined in **AWWA 10084**, or by use of a D.O. probe and an average shall be obtained on the samples for each sampling time.
- (7) A semi-log plot of the data of the D.O. deficit against time shall be constructed. Only points between 10 and 90 percent

saturation shall be considered. A line of best fit shall be drawn through the plotted points.

- (8) The slope of the line shall be calculated.
- (9) Corrections shall be made for temperature, oxygen saturation of the water, and the relative transfer coefficient of the water and then the pounds of oxygen dissolved at standard conditions of 20 degrees C 68 degrees F tap water, and "0" ppm dissolved concentration shall be computed.
- (10) Should diffusers fail to produce the oxygenation capacity required, the series of tests shall be repeated.
- (11) If the required oxygenation capacity is not produced after two test repetitions, the Contractor shall either correct the defective unit(s) or replace them with new unit(s), and the test procedure shall be repeated as set forth herein, until satisfactory units are obtained.

b. **Mixing Tests:** Mixing test shall be performed as follows:

- (1) Velocity measurements shall be made throughout the tank under actual operating conditions to test for complete mixing of tank contents.
- (2) This test shall be conducted at the same time as the oxygenation capacity test.
- (3) Measurements shall be taken at the quarter points of each tank wall, 600 mm 2 feet from the wall, and at the levels of the sample pumps used in oxygenation capacity tests. Minimum velocity shall be 0.18 meters per second 0.6 fps. Measurements shall be taken with a current meter.
- (4) Should any of the velocity measurements fall below the specified minimum velocity, the test shall be repeated.
- (5) If the specified minimum velocity is not produced after two test repetitions, the Contractor shall either correct the defective unit(s) or replace them with new unit(s), and the test procedures shall be repeated as set forth herein, until satisfactory units are obtained.

3.10.3.5 Hypochlorinator Tests

NOTE: Delete this paragraph when hypochlorinator is not required. Hypochlorinator should be specified for all plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator should be specified for all plants 6.57 L/s 150,000 GPD capacity and above. Between 4.38 and 6.57 L/s 100,000 and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

The pulley and belt drive shall be inspected and adjusted for the average

flow of feed solution desired. The capacity of the feeder shall be tested for a period of not less than 2 hours nor more than 6 hours. The following tests shall be made:

- a. Check the unit for leaks.
- b. Determine the amount of chemical solution used during the test run to ascertain if the unit is functioning within the prescribed limits of the feed rate indication plus 15 percent.
- c. The unit shall shut off automatically when the liquid elevation in the chlorine contact tank drops below the contact sensing probes and start when the water rises. The unit shall start and stop 10 times out of 10 consecutive starts.

3.10.3.6 Chlorinator Tests

NOTE: Delete this paragraph when chlorinator is not required.

The unit shall be operated for a period of not less than 2 hours nor more than 6 hours. The tests to be performed shall be as follows:

- a. The unit shall be checked for leaks. The shall be done by using an aqueous ammonia solution on a cotton or cloth swab on a wooden stick held close to all connections of the chlorinator.
- b. Determine the amount of chlorine used during the test run to ascertain if the unit is functioning within the prescribed limits of 4 percent of the set feed rate.
- c. The chlorinator shall be stopped when the water supply is interrupted or shut off.
- d. When the gas supply is exhausted or shut off, there shall be no back-flow of water into the unit.

3.10.3.7 Air Lift Pump

The air lift pump shall be tested for discharge capacity in **liters per second** **gallons per minute** of clean water. This shall be based on percentage of submergence of the eductor pipe to the total height of the eductor pipe. The amount of air in **L/s** **cfm** required to lift **1.26, 2.52, and 3.16 L/s** **20, 40, and 50 gallons per minute** of clear water shall be determined. The air throttling valve shall be tested and adjusted to provide the desired discharge rate. Test all joints in airline for leaks at **689.4 kPa** **100 psi** pressure.

3.10.3.8 Flow Measuring Equipment

V-notch weir shall be tested for accuracy of flow measurements as stated by equipment manufacturer. Tests shall be made using clear water, using suitable measuring containers. Accuracy shall be plus or minus 2 percent of the actual rate over a five-to-one range.

3.10.3.9 Electrical Control System Tests

The plant manufacturer's representative shall inspect the installation of the electrical control system with the Contracting Officer and check circuits and connections to all motors and electrical controls. The manufacturer's representative shall, upon satisfactory operation of all circuits and controls transmit to the Contracting Officer, three copies of letter certifying that the wiring is complete in accordance with the intent of the specifications for both manual and/or automatic operation and proper functioning of the sewage treatment plant.

3.10.4 Operating Instructions

Printed operating instructions specified hereinbefore will be reviewed by the Contracting Officer with the plant manufacturer's representative at the site. Each major piece of equipment shall have a name plate attached to it indicating characteristics of the equipment such as: name, capacity, watts HP, rpm, voltage, model or serial number. Also, each operating piece of equipment shall have a metal or plastic tag, non-corrosive type, with a number, name, or letter corresponding to one given in a flow diagram (isometric drawing) of the plant to be furnished by the manufacturer.

3.10.5 Plant Start-Up

Before allowing any liquid to discharge into the tanks, all tanks, chambers, channels, launders, piping and pieces of equipment shall be clean and free of any debris such as pieces of wood, concrete or leaves. Manufacturer's representative shall be present at plant start-up. The Contracting Officer will also be present so that he will become familiar with each piece of equipment and its proper operation and function. The manufacturer's manual on operation and maintenance shall be followed, step by step, so that as each piece of equipment is put into operation, the manufacturer's representative shall explain in detail its function. Once the plant is filled with water or sewage, the flow diagram furnished shall be followed and checked out with the on-site inspection.

The adjusting of equipment shall be made as required. The plant shall be examined to determine if it is structurally sound. All defects noted shall be reported and corrected. If no defects are detected, this shall be reported.

3.11 WORK INCLUDED UNDER OTHER SECTIONS

NOTE: Delete reference to piling when not required for plant foundation. On the project drawings, show:

- 1. Type of plant: (Extended aeration, Step Aeration, or Complete Mixing).**
- 2. Design flow.**
- 3. 5-day BOD loading.**
- 4. Suspended solids loading.**
- 5. Whether a comminutor is needed for plants 1.09 L/s 25,000 GPD or less in size.**

6. Whether mechanical aerator should be allowed.
7. Whether plant should be concrete only, steel only, or either concrete or steel at Contractor's option.
8. Whether piling is required for foundations.
9. Whether hypochlorinator or whether chlorinator should be used for plants in **4 .38 to 6.57 L/s** **100,000 to 150,000 GPD** range.
10. Whether raw sewage recirculation box (recirculation to pumping station) is needed.
11. Whether plant is to be of aboveground or belowground construction.
12. Seismic loading (if necessary).
13. Electric power characteristics for motors.
14. Whether automatic operation of air lift pumps should be required.
15. Wind load and ice load for rotating sludge collector.
16. Organic loading (5-day BOD) if other than that given in the text.
17. Total suspended solids if other than given in the text.
18. Size of hypochlorite mixing tank if larger capacity than **113.4 L 30 gallons** is needed.
19. Size of hypochlorite solution tank if larger capacity than **208 L 55 gallons** is needed.
20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

NOTE: Insert appropriate Section numbers and titles in blanks below using format per UFC 1-300-02, "Unified Facilities Guide Specifications (Ufgs) Format Standard".

Earthwork not specified herein is included under [____]. Concrete work not specified herein is included under [____]. [Piling is included under [____].] Field painting not specified herein is included under [____]. Piping and valves not specified herein are included under [____]. Electrical work not specified herein is included under [____].

3.12 DELIVERY AND STORAGE

All equipment and parts shall be packaged for shipment to prevent breakage, damage or cause out-of-adjustment calibration, readings, or controls. Materials delivered to the site shall be inspected for damage and shall be unloaded and stored with a minimum of handling. Only structural steel members, steel plates, boxes, channels, weirs and baffles may be stored outdoors, off the ground, and under a weathertight covering. All equipment shipped separately and not mounted on the plant shall be stored indoors, off the floor. The area shall be dry with adequate ventilation, free from dust or water, and shall permit easy access for inspection and handling. Prefabricated steel plants shall be lifted off the truck at the site and placed on the prepared concrete slab. During inclement weather, the Contractor shall cover the plant until such time that an inspection can be made of the equipment delivered to assess any damage, if any has occurred in transit. The Contractor shall be responsible for material delivered and stored at the site or other location. Contractor shall take measures for security of the equipment and it will be the his sole responsibility up to the time of acceptance of the plant by the Contracting Officer.

-- End of Section --