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USACE / NAVFAC / AFCEC / NASA **UFGS-02 51 13 (May 2010)**

Preparing Activity: USACE **Superseding**
UFGS-02 51 13 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 02 - EXISTING CONDITIONS

SECTION 02 51 13

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SECTION 02 51 13

PRECIPITATION/COAGULATION/FLOCCULATION WATER TREATMENT
05/10

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NOTE: This guide specification covers the requirements for precipitation/coagulation /flocculation (P/C/F) systems with flow rates ranging from 4 to 940 liters 1 to 250 gallons per minute.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This Section is intended for specification of PCF unit processes and is specifically applicable for remediation of ground water and landfill leachate containing dissolved heavy metals. This guide specification should not be used until thorough, site specific treatability studies (jar testing) have been performed, clearly demonstrating that P/C/F is an appropriate treatment technique that can meet the performance criteria set forth in this Section.

****

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 Reference Identifier (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 PETROLEUM INSTITUTE (API)

API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA D100	(2011) Welded Steel Tanks for Water Storage
AWWA D103	(2009; Errata 2010; Addenda 2014) Factory-Coated Bolted Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A283/A283M	(2013) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM C582	(2009) Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment
ASTM D2035	(2019) Standard Practice for Coagulation-Flocculation Jar Test of Water
ASTM D3299	(2010) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ANSI/ISA 5.1	(2009) Instrumentation Symbols and Identification

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Services Users Guide

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2019) Structural Engineering

1.2 P/C/F SYSTEM DESCRIPTION

****

NOTE: The system described in this paragraph includes the P/C/F equipment required for a water treatment plant to remove dissolved metals. The system can be a stand-alone system, or it can be a pretreatment system for other systems such as air stripping, advanced oxidation, activated carbon, etc. Ancillary P/C/F equipment which may be required for pre-treatment or post-treatment of the water is also described and includes an equalization unit, an oxidation/reduction unit, a clarification unit, a post-pH adjustment unit, and an effluent holding unit. The precipitation, coagulation, and

flocculation units may be supplied by the Contractor as individual pieces of equipment or as a single, integral unit. Typically, if a single unit is supplied, it will incorporate the coagulation, flocculation, and precipitation equipment within a clarification unit. Alternately, a unit may be supplied which performs two of the processes, e.g., precipitation and coagulation within one unit.

This paragraph should be edited to identify only the necessary equipment to suit conditions at the project site. The design team should review treatment objectives, water characterization data, and results of previously conducted treatability testing and other predesign information to determine the equipment required.

****

The Precipitation/Coagulation/Flocculation (P/C/F) system shall be a fully integrated water treatment plant which shall remove dissolved heavy metals and solids from [groundwater] [and] [landfill leachate] [_____]. The system shall include equipment for [flow equalization,] wastewater conveyance, precipitation, coagulation, flocculation, clarification, [post-pH adjustment,] and treated effluent storage required to meet the specified performance requirements. The P/C/F system shall be complete with required instruments, controls, and local control panels. A main control center shall be provided to facilitate the overall control of the treatment plant. All parts shall be factory or shop preassembled to the maximum extent possible, compatible with transportation limitations and equipment protection considerations. Field assembly shall be minimized to the assembly of match-marked components. Submit installation instructions and framed, typed operating instructions for posting and explaining methods of checking the system for startup and normal safe operations, normal and emergency shutdown operations, and procedures for safely starting and stopping each piece of equipment within the system.

1.2.1 Equalization Unit

Equalization unit shall include [one tank] [[_____] tanks] with accessories, mixers, piping, valves, [pumps,] motors, and instrumentation and controls to provide a constant flow and contaminant concentration to the subsequent treatment equipment. All components of the unit shall be furnished as shown on the drawings.

1.2.2 Oxidation/Reduction Unit

****

NOTE: Delete this paragraph if the contaminants in the water to be treated do not include metals which require reduction prior to precipitation (e.g., chromium 6+), or metals which require oxidation prior to precipitation (e.g., iron or manganese).

****

[Reduction unit shall include a mix tank, a mixer, a chemical feed system for acid addition, a chemical feed system for the reducing agent addition, piping, valves, pumps, motors, pH controls, oxidation-reduction potential (ORP) controls, and other instrumentation and controls as indicated on the drawings.] [Oxidation unit shall include a mix tank, a mixer, a chemical

feed system for oxidant addition, piping, valves, pumps, motors, oxidation-reduction potential (ORP) controls, and other instrumentation and controls as indicated on the drawings.]

1.2.3 Precipitation Unit

Precipitation unit shall include a mix tank, a mixer, a chemical feed system for the precipitant addition, piping, valves, pumps, motors, pH controls, and other instrumentation and controls as indicated on the drawings.

1.2.4 Coagulation Unit

Coagulation unit shall include a mix tank, a mixer, a chemical feed system for the coagulant addition, piping, valves, pumps, motors, and instrumentation and controls as indicated on the drawings.

1.2.5 Flocculation Unit

Flocculation unit shall include a tank with accessories (e.g., nozzles, supports, lifting lugs, etc.), a mixer, a chemical feed system for the coagulant aid addition, piping, valves, pumps, motors, and instrumentation and controls as indicated on the drawings.

1.2.6 Clarification Unit

Clarification unit shall include an inclined plate or tube type settler with all necessary accessories (e.g., inlet distribution system, separator module, skimmer, etc.), [a thickener,] a sludge removal system, piping, valve, pumps, motors, and instrumentation and controls as indicated on the drawings.

1.2.7 Post-pH Adjustment Unit

Post-pH adjustment unit shall include piping, chemical feed systems for both acid and base addition, and in-line pH instrumentation and controls as indicated on the drawings.

1.2.8 Effluent Holding Unit

[One effluent holding tank] [[_____] effluent holding tanks] shall be supplied to store treated water for testing prior to discharging. Tanks shall include all piping, valves, sample taps, pumps, and instrumentation and controls as indicated on the drawings.

1.3 PERFORMANCE REQUIREMENTS

****

NOTE: The designer, in consultation with the appropriate technical team personnel, should use the treatability testing results and other predesign information to set influent parameters, such as maximum and minimum ground water and landfill leachate flow rates, maximum and minimum temperatures, pH, viscosity, density, and maximum and minimum influent metals and solids concentrations. The required effluent quality is typically established by federal, state, or local agency permit or regulation.

The designer should consider that fugitive emissions from landfill leachates or contaminated groundwater may have volatile components. Federal, state, or local air regulations should be consulted to establish allowable air emissions for the P/C/F system.

Performance requirements for the Contractor will indicate that the supplied equipment must be operated to meet the required effluent quality. Performance requirements for the Contractor stated in this paragraph should only apply to the performance of the complete system and not individual pieces of equipment. Performance criteria and minimum equipment standards for specific equipment should be listed under PART 2 PRODUCTS, where applicable.

Flow rates specified for the P/C/F system should be consistent with the pumping rates required by Section 23 21 23 HYDRONIC PUMPS or 22 13 29 SANITARY SEWERAGE PUMPS.
****

Provide a P/C/F system which is capable of processing [ground water] [landfill leachate] [_____] at the conditions provided below:

Flow Rate	
Maximum	[_____] L gal per minute
Minimum	[_____] L gal per minute
Temperatures	
Maximum	[_____] degrees C F
Minimum	[_____] degrees C F
Influent/Effluent pH	
Maximum Influent	[_____]
Minimum Influent	[_____]
Maximum Effluent	[_____]
Minimum Effluent	[_____]
Liquid Properties	
Liquid Viscosity	[_____] centipoise lb-sec/(sq. ft.)

Liquid Density	[_____] gm/ml at [_____] degrees C F
Maximum Air Emissions	
Particulates	[_____] ppmv
Volatile Organic Compounds	[_____] ppmv
[_____]	[_____] ppmv
Space Availability	
Maximum Area	[[_____] m feet by [_____] m feet] [[_____] square meters feet]
Maximum Height	[_____] m feet

The P/C/F system shall be capable of meeting the maximum effluent metals and solids concentrations achieved in the previously conducted treatability testing (report appended to this specification), as listed below at the indicated maximum concentrations. Influent and effluent solids are as determined in accordance with Part 2000 Physical and Aggregate Properties, and metals as determined in accordance with Part 3000 METALS of AWWA 10084:

	Maximum Influent Concentration mg/L	Maximum Effluent Concentration mg/L
Total Cadmium	[_____]	[_____]
Hexavalent Chromium	[_____]	[_____]
Total Chromium	[_____]	[_____]
Total Copper	[_____]	[_____]
Total Iron	[_____]	[_____]
Total Lead	[_____]	[_____]
Total Mercury	[_____]	[_____]
Total Nickel	[_____]	[_____]
Total Silver	[_____]	[_____]
Total Zinc	[_____]	[_____]
TSS	[_____]	[_____]

	Maximum Influent Concentration mg/L	Maximum Effluent Concentration mg/L
TDS	[_____]	[_____]

P/C/F system instrumentation and controls shall have the necessary accuracy and sensitivity to measure and control the operating ranges of the specified equipment. Sampling and analysis shall be performed in accordance with [_____].

1.4 RESULTS OF PREVIOUSLY CONDUCTED TREATABILITY STUDIES

****

NOTE: Treatability testing reports should be appended to this specification to enable the Contractor to make a full evaluation of the testing methodologies used, the results of the testing, and to evaluate the completeness of necessary data gathering. The Contractor will use these treatability testing reports along with the required effluent quality to select the specific P/C/F equipment (including ancillary equipment) required to meet the specified performance requirements.

****

Even though methodologies and results of the previously conducted treatability studies in Appendix [_____] have demonstrated that P/C/F is capable of meeting the post treatment criteria identified in this section, perform an independent evaluation of these studies and results in accordance with ASTM D2035. Based on the Contractor's own interpretation of all treatability study results, provide a full scale treatment plant which meets the performance requirements identified in this section.

1.5 UTILITIES

****

NOTE: The locations and details (such as utility point of contact, sizes, capacities, and flows) of the utility hookups should be provided on the drawings for the Contractor to use.

****

Provide the utilities associated with the installation and operation of the treatment plant including, but not limited to: telephone, electricity, water, [gas], sanitary and solid waste facilities. The [telephone] [electricity] [_____], [steam] [water] [gas] [sanitary] [_____], and [solid waste facilities] [_____] are available at the site. Refer to the drawings for hookup locations.

1.6 OTHER SUBMITTAL REQUIREMENTS

The following shall be submitted:

a. Detailed drawings of clarifiers showing the dimensions, nozzle orientation and elevations, interconnecting piping, equipment layout, hydraulic profile, and other details required to demonstrate that the

unit has been coordinated and will properly function as part of the overall P/C/F system. Drawings shall show proposed layout, foundation requirements, anchorage of equipment and accessories, installation/connection details, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation. Submit manufacturer's descriptive data, specifications, technical literature, utility requirements, performance charts and curves, and catalog cuts for the clarifier.

b. Electrical one-line diagrams for instrumentation and controls, illustrating all electrical components (motor controls, disconnects, starters, selector switches, pushbuttons, pilot lights, conduit, wire, etc.), electrical load analyses, cable and conduit schedules (including conduit designation, materials of construction, descriptions for each conduit of the end points of each conduit segment in a run, wire count by number, type and size, wire length, etc.), and complete control ladder logic diagrams. All control ladder logic diagrams shall be fully coordinated between components and ladder rungs to illustrate component tag names for all relays, timers, selector switches, pushbuttons, pilot lights, etc. All wires and terminals shall be number tagged. Terminal designations shall distinguish between terminals contained within differing enclosures such as control panels, equipment enclosures, motor control centers, etc. All auxiliary relay contacts shall be illustrated and designated. All ladder rungs shall be numbered with cross referencing between all associated rungs. A narrative description shall be fully coordinated with the ladder logic diagrams so as to fully describe all control operations, sequences, interlocks, alarms, and shutdowns for the P/C/F system including, but not limited to, flow control systems, level control systems, pH/ORP control systems, chemical addition control systems, pump/valve controls, alarm and shutdown schemes, PLC input/output points, and all component interlocking. Locations of all control panels, equipment enclosures, motor control centers, etc. shall be designated on an equipment layout drawing. Submit manufacturer's descriptive data, specifications, technical literature, utility requirements, performance charts and curves, and catalog cuts for each instrument and control component supplied.

c. A pre-startup test plan identifying the procedures and methods that will be used to verify the integrity, calibration, and operability of the equipment, piping, electrical wiring, and instruments and control systems. The plan shall specify acceptance criteria and tolerances to be achieved during the pre-startup testing.

d. A list of the P/C/F system and specify its required performance criteria when operated using contaminated water. The test plan shall describe the operating procedures to be followed during the test period including detailed descriptions of the measurements, record keeping, sampling and analyses to be performed to document that performance criteria has been achieved. The plan shall address full-scale operation of all equipment, piping, electrical wiring, and instruments and control systems included in the P/C/F system.

e. Manufacturer's certificates attesting that the equipment meets the specified requirements. The statement shall be dated after the award of the contract, shall state the Contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified. Certificate shall indicate the methods of testing used.

f. [Six] [_____] copies of operation and maintenance manuals for the P/C/F system containing the manufacturer's operating and maintenance instructions for each piece of equipment. Provide one complete set prior to the performance of the field test (see Paragraph Tests); submit the remaining sets prior to startup. Furnish each set in loose leaf three-hole ring binders. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name of equipment, name and location of the building, name of the Contractor, and contract number. Place cover sheets before instructions identifying each subject. Use standard letter size paper for instruction sheets, with larger sheets of drawings folding in to approximately the same size. Include, but do not limit the instructions to the following:

(1) System layout detailing piping, valves, and controls.

(2) Approved wiring and control ladder logic diagrams prepared in accordance with ANSI/ISA 5.1 including a drawing index, legend and symbols list, and abbreviation and identifiers.

(3) A narrative control sequence describing startup, operation, and normal and emergency shutdown. This information shall include the detailed operational narrative described in Paragraph Control System.

(4) Operating instructions for each equipment, instruments and control system including process monitoring requirements and recommendations for operations reporting to document the results of all process monitoring.

(5) Maintenance instructions for each piece of equipment, including lubrication instructions and a troubleshooting guide to help the operator determine what steps shall be taken to correct anticipated problems that may occur in the system.

(6) Manufacturer's bulletins, cut sheets and descriptive data of equipment; these shall be submitted after approval of detail drawings, and not later than [2] [_____] months prior to delivery of the system.

1.7 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Tanks; G[, [_____]]
Mixers; G[, [_____]]
Clarifiers; G[, [_____]]
Instrumentation and Control; G[, [_____]]
Structural Skids; G[, [_____]].

SD-03 Product Data

Tanks; G[, [_____]]
Mixers; G[, [_____]]
Clarifiers; G[, [_____]].
Instrumentation and Control; G[, [_____]]
Spare Parts
Regulatory Requirements
Pre-startup Testing; G[, [_____]].
Startup and Operation; G[, [_____]]
Proof of Performance; G[, [_____]]
P/C/F System; G[, [_____]]
Qualifications

SD-06 Test Reports

Tests.
Field Quality Control

SD-07 Certificates

Equipment Certificate of Conformance

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual Updates

1.8 QUALITY ASSURANCE

****

NOTE: The designer should review all federal, state, and local regulations to determine the applicable regulations which may impact the design of the P/C/F system. Specifically, water regulations should be reviewed to determine the required effluent quality for a specific site. Air regulations should be reviewed to determine if tank covers, vents, and emission control devices are required. Hazardous waste regulations, which cover tank standards and secondary containment, may apply where the groundwater or leachate being treated is classified as a hazardous waste.

****

1.8.1 Regulatory Requirements

Obtain all permits, certifications, and/or meet the regulatory requirements necessary for the configuration, installation, startup, and operation of the treatment plant. Work shall meet or exceed applicable minimum requirements established by federal, state, and local laws and regulations. Notify the Contracting Officer within 30 days of a change in regulatory requirements which may affect the contract. Submit permits, certifications, and/or substantive regulatory requirements before work starts plus copies of applications for permits and certifications not required until later, along with a schedule for obtaining them. Equipment, raw materials (including reagents/additives), contaminated materials, and treated materials shall be safely transported, stored, and handled in accordance with Sections 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS and 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

1.8.2 Qualifications

Contractor and subContractors shall demonstrate that their capabilities and experience with similar P/C/F systems and applications are adequate to supply, install, and operate a P/C/F system to remediate [ground water] [and] [landfill leachate] [_____] by providing descriptions of at least [2] [_____] P/C/F full-scale remediation projects. Provide a field team (consisting of [ground water] [and] [landfill leachate] [_____] unit operators, quality control personnel, health and safety personnel, supervisory engineering, and technical staff) qualified to install and operate the treatment system. Field team personnel shall have a minimum of [_____] years experience in the installation and operation of similar treatment systems and shall show evidence of satisfactory operation for each installation. Welding procedures and welders shall be qualified in accordance with the code under which the welding is specified to be accomplished. Submit [one] [_____] [copy] [copies] of qualified procedures and list of identification symbols and names of certified welders and welding operators prior to the commencement of welding operations.

1.9 DELIVERY, STORAGE, AND HANDLING

Equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and temperature variation, and dirt, dust or other contaminants.

1.10 SITE CONDITIONS

1.10.1 Ambient Conditions

****

NOTE: When temperatures are below freezing, the treatment plant equipment may not function properly and efficiently. The general practice is to avoid the operation of an outdoor treatment plant during extreme winter weather. In places where there is a long winter season or in projects where plant operation is required throughout the year to meet the project schedule, the remediation activities should be performed inside a building with proper heating and ventilation. For outdoor operations, piping and equipment should be designed with freeze protection by insulation and heat-tracing.

****

P/C/F system shall [be operated continuously] [not be operated] [_____] during the winter when temperatures reach freezing or below. The system shall be installed [outdoor] [indoor] [_____]. Outdoor equipment shall have [insulation] [_____] and [heat tracing] [_____]. The system shall be equipped with sufficient lighting as shown on the drawings for security purposes and for treatment plant operation during inadequate daylight or at night. Refer to Sections 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and 26 56 00 EXTERIOR LIGHTING for proper heating, ventilation, air conditioning, and illumination.

1.10.2 Existing Conditions

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the second bracketed phrase at the end of this paragraph if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC, properly edited, must be included in the contract documents.

****

The P/C/F system shall operate in a [remote] [urban] [industrial] [commercial] [residential] setting. Contractor shall become familiar with the existing site conditions, including site location, site configuration, topography, climate, site accessibility, and adjacent land use. The P/C/F system shall be designed for a soil bearing capacity of [_____] MPa psf. Seismic protection shall be [in accordance with UFC 3-301-01] [as shown on the drawings].

PART 2 PRODUCTS

****

NOTE: The designer should review the methodologies and results of the previously conducted treatability testing and other predesign information, along with the required effluent quality, to determine the types and sizes of equipment, the chemicals, and chemical dosages to be specified.

As a minimum, the designer should provide a process flow diagram (PFD), a piping and instrumentation diagram (P&ID), an instrument index, a site layout drawing, and an equipment layout drawing. The PFD should depict the P/C/F and ancillary equipment required for the specific water to be treated and display the process design conditions for each unit. Such process design conditions should include consideration of minimum, average, and maximum values of each significant parameter (e.g. pressure, temperature, flow rate, etc.). The P&ID should define all piping and instrumentation of the system and should include descriptive tag names for all piping and fittings including materials of construction, tag number, and line size. The P&ID drawings should also include tag numbers for all instruments in accordance with ANSI/ISA 5.1. The instrument index should include drawings detailing the types of instruments to be used, their range and scale, related appurtenances, and their associated tag numbers; all such information must be coordinated with the P&ID.

The designer should verify that the appropriate (on/off, proportional, set point, etc.) controller to be used in the P/C/F system for chemical feed control is specified in Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS. The designer should provide a site layout drawing to indicate to an equipment supplier what the general location of the equipment will be and how much space is available for the proposed equipment. The designer should also provide a detailed equipment layout drawing that identifies all the major equipment and their related orientations inside the site plan. This equipment layout drawing should indicate where off-site piping and utility lines enter and/or leave the site. If the equipment layout drawing is only a suggestion or recommendation to the Contractor, the designer should so state on the drawing.

****

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be new and unused, except for test equipment. Where two or more pieces of equipment

performing the same function are required, they shall be products of the same manufacturer. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, capable of providing service, materials, and equipment in an expedient manner.

2.2 TANKS

Submit detailed drawings of each tank showing the dimensions, nozzle orientations and elevations, interconnecting piping, equipment layout, hydraulic profile, and any other detail required to demonstrate that the tank has been coordinated and will properly function as a part of the overall P/C/F system. Drawings shall show proposed layout, foundation requirements, anchorage of equipment and accessories, installation/connection details, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation. Submit manufacturer's descriptive data, specifications, technical literature, and catalog cuts for each tank supplied.

2.2.1 General Requirements

****

NOTE: When required by the corrosive nature of stored water, lack of proper maintenance facilities, or by climatic conditions, this paragraph will be modified to provide for corrosion allowance.

Determine basic wind speed from ASCE-7. The designer will choose between the AWWA and API procedures. Use 1200 Pa 25 psf snow load for most heavy snow climates; delete snow load where maximum snow is insignificant. In some cases, local climate and topography will dictate that a value greater than 1200 Pa 25 psf be used for snow loading.

In some application, wastewaters may require closed tanks to contain and/or control air emissions. VOCs from landfill leachate or groundwater from contaminated plumes can require closed tanks for the entire system. Show all process nozzles, spare nozzles, vents, drains, and manholes on the P&ID. If tanks are located inside a room or building, the designer can delete the wind loading requirements.

****

Use manufacturer's standard size tanks whenever possible. Tank construction material and paints, coatings, or liners shall be compatible with the wastewater to be stored. Tank dimensions shall be selected to fit the available space as shown on the drawings. Unless noted otherwise on the drawings, each tank shall include, flanged fittings for inlet, outlet, overflow, and drain. Manholes shall be provided when shown on the drawings. Hold down lugs shall be provided to anchor the tank to the base. Influent and effluent baffles and weirs shall be provided to avoid short circuiting. Tank geometry shall be combined with mixer design to avoid dead spots and excessive turbulence relative to internal tank baffles and mixer orientation. Complete mixing shall be provided. Tanks to be supplied as part of the P/C/F system shall meet the following nominal size requirements:

Type of tank	Design Hydraulic Retention Time (HRT)	
	Minimum	Maximum
Equalization Tank	[2] [_____] hrs	
Oxidation/Reduction Tank	[5] [_____] min	
Precipitation Tank	[5] [_____] min	
Coagulation Tank	[1] [_____] min	[2] [_____] min
Flocculation Tank	[20] [_____] min	
Effluent Holding Tank	[5] [_____] min	
[_____]	[_____] min	

Design, fabrication, and erection of the tank shall be in accordance with [AWWA D100] [API Std 650] [AWWA D103] except as modified herein. Minimum equipment design life: [_____] years. Tanks shall be designed for a [basic wind speed of [_____] km/hour mph in accordance with ASCE 7-16 or designed in accordance with [AWWA D100] [AWWA D103] [API Std 650] wind load design, whichever provides the greater pressure.] [snow load of [1200 Pa 25 psf] [[_____] kPa psf].] Factor of safety on overturning of elevated tanks under design wind load shall be 1.33 minimum. When a footing is required, an inverted truncated pyramid of earth with 2 on 1 side slopes above top of footing shall be used in determining overturning stability.

2.2.2 Tank Construction Materials

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NOTE: Tank shell thickness should be calculated using AWWA D100, AWWA D103, or API 650 procedures. The strength of the materials of construction for each tank should include allowances specified herein.

****

2.2.2.1 Carbon Steel

Carbon steel sheet shall be hot rolled in accordance with ASTM A283/A283M Grade C with a minimum yield of 476 MPa 40,0000 psi; minimum thickness shall be 3.4 mm 10 gauge. Structural steel shall conform to ASTM A36/A36M and [AWWA D100] [AWWA D103] [API Std 650] for steel tanks.

2.2.2.2 Polyethylene

Polyethylene tanks shall be manufactured in accordance with ASTM C582.

2.2.2.3 Stainless Steel

Stainless steel shall conform to the material specification for 304SS, 316SS, 316LSS, 317SS.

2.2.2.4 Structural Steel

Structural steel shall conform to ASTM A36/A36M.

2.2.2.5 Fiberglass

Fiberglass tanks shall conform to ASTM D3299.

2.2.3 Corrosion Allowance

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NOTE: The designer should specify a minimum corrosion allowance for wetted surfaces giving consideration to the types of liquids to be stored, the vapors above the liquids, and the atmospheric environment. It is expected that some tanks in the P/C/F system may have a low pH and some may have a high pH, and others will have contaminants and chemicals at varying concentrations. A corrosion allowance can be calculated using available corrosion rate information from material suppliers or National Association of Corrosion Engineers (NACE) standards. The designer should take into account the changes in temperature over the range of operating conditions and the effects of liquids and vapors on the materials of construction.

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Corrosion allowance is dependant upon the materials of construction and finish coatings and shall be as follows: For a lined interior finish, the corrosion allowance shall be [0.0 mm 0.0 inches] [_____]. For a coated or painted interior finish, the corrosion allowance shall be [0.0 mm 0.0 inches] [_____]. For tanks with no protective finish, the corrosion finish shall be [0.0 mm 0.0 inches] [_____].

2.2.4 Shop Fabrication

All welding shall conform to [AWWA D100] [AWWA D103] [API Std 650] using ASME certified welders. Shell seams shall be full penetration using Sub Arc Welding (SAW). Other seams shall be made with [Gas Metal Arc Welding (GMAC)] [Shielded Metal Arc Welding (SMAC)] [Flux Cored Arc Welding (FCAW)] [Submerged Arc Welding] processes.

2.2.5 Bolts

Bolts used in the shell joints shall meet the requirements of Section 2.2 of AWWA D103. Bolts used in tanks designed under [AWWA D100] [API Std 650] shall meet the requirements as specified in [AWWA D100] [API Std 650].

2.2.6 Gaskets

All bolted connections shall incorporate gaskets of suitable chemical resistance for the service. Gaskets used to seal bolted joints in tanks shall meet the requirements of AWWA D103 Section 2.10.

2.2.7 Accessories

2.2.7.1 Manholes and Pipe Connections

Manholes and pipe connections shall meet the minimum requirements of [AWWA D100] [AWWA D103] [API Std 650]. Number, type, elevation, orientation, and size of manholes and pipe connections shall be [as shown on the drawings] [provided by Contractor].

2.2.7.2 Baffles, Weirs, and Overflow Pipes

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NOTE: Design each tank with an overflow that will pipe, channel, or otherwise direct an overflowing tank to a containment area or to the next tank in the system. If a weir or exit pipe is plugged and cannot pass the maximum process flow rate, wastewater must be contained to prevent spills.

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Inlet baffles shall be designed to dissipate influent flow energy at maximum flow rates and to avoid short circuiting to effluent weirs. Weirs for the tanks shall consist of an overflow weir and outside drop pipe, adequately supported and capable of discharging the design flow rate with [_____] mm inches of head. [Top of the weir shall be [_____] mm inches below [the top edge of the tank] [overflow height].] [Weir shall be located as indicated.] All tanks shall have emergency overflow outlets to direct overflow of wastewater to a containment area. Overflow pipe shall terminate 300 to 600 mm 1 to 2 feet above grade and shall be fitted with a flapper valve or screen to prevent ingress of birds, insects, or small animals of any kind. Design of internals shall meet the requirements of [AWWA D100] [AWWA D103] [API Std 650].

2.2.7.3 Vents

****

NOTE: Vents on covered tanks should be designed to allow vapor control systems to be attached. Design tank vents in accordance with guidelines published in the American Institute of Chemical Engineers (AICHE) G3 "Guidelines for Safe Storage and Handling of High Toxic Hazard Materials" (1988), and API Publication 2557 "Vapor Collection and Control Options for Storage and Transfer Operations in the Petroleum Industry" (1993).

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On covered tanks, vent shall be welded to a cover plate on the roof. Vent shall be tank manufacturer's standard type mushroom vent with bird and insect screen. Vent shall be designed as specified by [AWWA D100] [AWWA D103] [API Std 650]. The open area of a vent screen shall be sized 50 percent in excess of the [_____] L/second gpm pump-in rate and [_____] L/second gpm pump-out rate. Screening for vent shall conform to [AWWA D100] [AWWA D103] [API Std 650] ensuring fail-safe operation in the event that screen frosts over. The bottom of the screen shall be sufficiently elevated for snow consideration in the area.

2.2.7.4 Ladders and Safety Devices

Provide an outside access ladder on tanks greater than 1.5 m 5 feet in height. Ladders and safety devices shall be provided in accordance with [AWWA D100] [AWWA D103] [API Std 650]. Location of ladders shall be as shown on the drawings. In addition, safety cage, rest platforms, roof ladder handrails, and other safety devices shall be provided as required by federal or local laws or regulations.

2.2.7.5 Scaffold and Cable Support

Tanks shall include attachment rings or hooks on the inside and outside of closed top tanks, at four points at the top of walls, to secure scaffolding and cable support during maintenance activities.

2.2.7.6 Miscellaneous Tank Accessories

Miscellaneous tank accessories, such as support legs, saddles, skirts, lifting lugs, etc., shall conform to [AWWA D100] [AWWA D103] [API Std 650].

2.3 CHEMICAL FEED SYSTEMS

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NOTE: The designer must verify that appropriate (on/off, proportional, set point) controller is specified in Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

****

Chemical feed systems shall be provided in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS. Control signals and wiring to the chemical feed controllers shall be furnished in accordance with the requirements of this section.

2.4 MIXERS

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NOTE: Different types of mixers can be used for a P/C/F treatment system including: impeller, jet and in-line static mixers. Delete items that are not required. Impeller mixers are divided into three groups: propellers, turbines, and paddles. Turbine and propeller mixers are used for rapid mixing applications while paddle mixers are typically used in flocculation.

Propeller mixers are high speed mixers, operated on low horsepower, which are used primarily for flash mixing applications. Propeller speeds range from 400 rpm to 1750 rpm. When top entry is required, the propeller mixer is mounted angled and off center. Where side entry is recommended, the propeller mixer is mounted horizontally, offset from the centerline of the tank.

Turbine mixers are primarily used in low speed applications where heavy solids may be generated and a large mixing energy input is required to keep the solids in suspension. These type mixers can be used for equalization of the wastewater, flash mixing or flocculation. Turbine speed ranges from 55 to 125 rpm. The turbine mixer is typically mounted vertical, one half to one diameter off the floor of the mixing chamber. In an unbaffled tank the unit is mounted off center. In a baffled tank the unit is mounted on center.

Paddle mixers are low speed mixers whose peripheral

paddle speed typically varies from 0.15 to 0.61 m/sec 0.5 to 2.0 feet/second. Paddle mixers are used primarily in flocculation applications.

Jet mixers use hydraulic action for mixing resulting in lower capital and operating costs as compared to impeller mixers. Jet mixers are used only for rapid mixing, and are not suitable for flocculation due to the high pressure liquid ejected at the discharge nozzle, which can break up the floc previously formed.

Static mixers are typically installed downstream of chemical addition points for blending or dispersion applications. They are used in combination with metering pumps and must be sized based on the flow rate. In-line static mixers use hydraulics for mixing instead of impellers, requiring no external power and no maintenance. In-line static mixers have high head losses up to 1 m 3 ft; and the mean temporal velocity gradient G cannot be changed to meet varying requirements.

Mixers are usually sized based on liquid viscosity, liquid temperature and liquid density among other parameters. However for each of the mixing locations, at most sites, it is expected that the viscosity and density will not be significantly different from water; if that is not the case, the designer should specify the requirements that the mixing device must meet.

****

Mixers shall be furnished on each tank or unit as designated on the drawings. On tanks, supply tank baffles, where required by the mixer design, to achieve complete mixing and mixer support as required. Submit detailed drawings of each mixer including dimensions, mounting details, wiring, schematics, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Submit manufacturer's descriptive data, specifications, technical literature, utility requirements, performance charts and curves, and catalog cuts for each mixer supplied.

2.4.1 Equalization Unit Mixer

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NOTE: Because the water level in the equalization tank varies, the designer must specify the minimum water level at which the mixer will be turned off to avoid burning out the mixer motor.

****

Mixers shall be a [propeller] [turbine] [paddle] [jet] type mixer. Number of mixers: [_____].

a. Propeller, turbine, or paddle mixers shall meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio shall be [4:1] [_____]. Mixer shall be

designed to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mixers shall be mounted [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. Mixer bearings shall be designed to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Jet mixer shall consist of, but shall not be limited to, a jet motive pump to circulate liquid in the mixing basin; jet mixing nozzle assembly, retrieval system and in-basin secondary fluid lines. Jet mixer shall be designed to obtain a maximum mean velocity of [100] [_____] sec-1 or G(t) values of [104] [_____]. The jet motive pump shall be driven by submersible non-clog units. Motors shall operate on 230/460 volt, three phase, 60 hertz power supply. Nozzle assembly and piping shall be made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

2.4.2 Precipitation Unit Mixer

Mixing shall be supplied by a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Propeller or turbine type mixers shall meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio shall be [4:1] [_____]. Mixer shall be designed to develop a maximum velocity gradient (G value) not less than [300] [_____] sec-1. Mixers shall be mounted [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. Mixer bearings shall be designed to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Jet mixer shall consist of, but shall not be limited to, a jet motive pump to circulate liquid in the mixing basin; jet mixing nozzle assembly, retrieval system and in-basin secondary fluid lines. Jet mixer shall be designed to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump shall be driven by submersible non-clog units. Motors shall operate on 230/460 volt, three phase, 60 hertz power supply. Nozzle assembly and piping shall be made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

c. In-line static mixers shall meet the following requirements. Maximum precipitant feed rate: [_____] L/s gpm. In-line static mixers shall have a helical shaped element which is made of the same material as the housing wall. Sealing edge between the element and housing wall shall create an integral unit without pieces to fatigue or vibrate. In-line static mixers shall incorporate the required number of elements to provide complete mixing at all design conditions. Mixer shall be sized to fit [_____] mm inches diameter conveying pipe. Materials of construction: [carbon steel] [stainless steel] [polyethylene] [polypropylene] [FRP] [Teflon] [_____].

2.4.3 Coagulation Unit Mixer

Mixing shall be supplied by a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Propeller or turbine mixers shall meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio shall be [4:1] [_____]. Mixer shall be designed to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mixers shall be mounted [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. Mixer support shall [be included] [not be included] [_____]. Mixer bearings shall be designed to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Jet mixer shall consist of, but shall not be limited to, a jet motive pump to circulate liquid in the mixing basin; jet mixing nozzle assembly, retrieval system and in-basin secondary fluid lines. Jet mixer shall be designed to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump shall be driven by submersible non-clog units. Motors shall operate on 230/460 volt, three phase, 60 hertz power supply. Nozzle assembly and piping shall be made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

c. In-line static mixers shall meet the following requirements. Maximum coagulant feed rate: [_____] L/s gpm. In-line static mixers shall have a helical shaped element which is made of the same material as the housing wall. Sealing edge between the element and housing wall shall create an integral unit without pieces to fatigue or vibrate. In-line static mixers shall incorporate the required number of elements to provide complete mixing at all design conditions. Mixer shall be sized to fit [_____] mm inches diameter conveying pipe. Materials of construction: [carbon steel] [stainless steel] [polyethylene] [polypropylene] [FRP] [Teflon] [_____].

2.4.4 Flocculation Unit Mixer

Mixers shall be [turbine] [paddle] type mixers. Number of mixers: [_____]. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio shall be [4:1] [_____]. Mixer shall be designed to develop a maximum velocity gradient (G value) no more than [100] [_____] sec-1. Mixers shall be mounted [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. Mixer support shall [be included] [not be included] [_____]. Mixer bearings shall be designed to operate continuously at full load for [100,000 hours] [_____] before replacement.

2.4.5 Effluent Holding Unit Mixer

Mixing shall be provided by a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Propeller or turbine mixers shall meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio shall be [4:1] [_____]. Mixer shall be designed to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mixers shall be mounted [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. Mixer support shall [be included] [not be included] [_____]. Mixer bearings shall be designed to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Jet mixer shall consist of, but shall not be limited to, a jet motive pump to circulate liquid in the mixing basin; jet mixing nozzle assembly, retrieval system and in-basin secondary fluid lines. Jet mixer shall be designed to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump shall be driven by submersible non-clog units. Motors shall operate on 230/460 volt, three phase, 60 hertz power supply. Nozzle assembly and piping shall be made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

2.5 CLARIFIERS

****

NOTE: This paragraph specifies only inclined plate or tube settlers. The inclined plate or tube settler requires minimum space, no moving parts (therefore minimizing maintenance), less potential for short circuiting, and generally lower capital and operating costs than conventional clarifiers. For metallic sludges, the overflow rate typically ranges from 2.1 to 4.2 L/s/sq. m 360 to 720 gpm/sq. ft. and generally will not exceed 5.9 L/s/sq. m 1000 gpm/sq. ft.

****

Clarifier shall be an inclined [plate] [or] [tube] settler and shall be designed to meet the following conditions:

a. Influent pH: Maximum [_____], Minimum [_____].

b. Solids Loading: [_____] kg/day lbs/day.

c. Effluent TSS: [_____] mg/L.

The effective surface overflow rate shall be [_____] L/m3/m2.s gpd/ft2 and the detention time shall [2] [_____] hours at the design flow rate. Clarifier shall consist of, at a minimum, the following accessories: influent distribution system, a separator module consisting of [corrugated plate packs,] [inclined tube packs,] skimmer mechanism with scum collection trough, sludge removal system, effluent collection flumes, access ladder, operating platform, associated piping, fittings, sampling valves, and a sludge hopper.

2.5.1 Clarifier Vessel

The bottom and sides of the clarifier vessel shall be 6 mm 1/4 inch minimum thickness carbon steel plate meeting or exceeding ASTM A36/A36M. Inlet, outlet, overflow, and drain connections shall be provided on the vessel. Structural steel framework shall be an integral part of the vessel to make it self-supporting. The clarifier shall be designed for seismic forces in accordance with paragraph Existing Conditions.

2.5.2 Influent Distribution and Effluent Collection Systems

Influent distribution system shall be supplied to dissipate the entrance energy and to equalize flow to the separator module. Weirs and baffles shall be included to control the local velocities and to eliminate short circuiting. Adjustable weirs shall be supplied along each effluent collection flume to maintain uniform flow distribution.

2.5.3 Separator Module

The separator module shall be formed by [parallel corrugated plates placed [38 mm 1-1/2 inches] [[_____] mm inches] apart] [inclined tubes at [45] [60] [_____] degrees from the horizontal]. The separator module shall be removable for maintenance and inspection. Separator module shall be constructed of corrosion resistant materials. [Corrugated plate packs] [Tube packs] shall be [fiberglass reinforced plastic] [polypropylene] [coated steel] [stainless steel] [_____].

2.5.4 Skimmer and Sludge Collection/Thickening Devices

Mechanical skimmer and drive shall continuously collect floating scum and remove it to a collection trough. Sludge holding compartment shall be equipped with hopper bottom having sides tapering downward at an angle not less than [55] [_____] degrees above horizontal for sludge collection. Sludge hopper shall be [fixed] [removable] [_____] and shall be equipped with a vibrator pack for sludge thickening. Sludge hopper shall provide a minimum of [_____] L gallons of sludge storage. A flanged outlet shall be provided for each hopper which connects to a pump for sludge removal.

2.5.5 Miscellaneous

Clarifier shall be supplied with a steel platform around the perimeter complete with ladder, handrail, and toe plates. Painting shall conform to Sections 09 90 00 PAINTS AND COATINGS and 09 97 02 PAINTING: HYDRAULIC STRUCTURES, unless otherwise indicated.

2.6 PIPING/VALVES

Piping and valves for chemical feed systems shall be in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS. Low point drains shall be installed in interconnecting piping.

2.7 PUMPS

Pumps shall conform to the following requirements. Pumps for specific services and accessories shall be as specified.

2.7.1 Water Pumps

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NOTE: Water pumps include, but are not limited to, the following: equalization transfer pumps, water pumps for chemical dilution, and effluent water recycle and discharge pumps. Water pumps may be horizontal or vertical centrifugal pumps. Delete and/or add paragraphs to meet job requirements.
****

Water pumps shall be designed in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.7.2 Chemical Metering Pumps

****
NOTE: Chemical metering pumps may be piston, positive displacement diaphragm, or balanced diaphragm pumps. The unit application depends on the pressure involved, corrosiveness of the chemical, feed rate, accuracy required, viscosity and specific gravity of the fluid, other liquid properties, and the type of control.
****

Chemical metering pumps shall be manufactured and installed in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

2.7.3 Sludge Pumps

****
NOTE: Sludge pumps may be centrifugal, diaphragm (air operated) or progressive cavity. The unit application depends on the pressure involved, the pumping rate (constant or variable), the specific gravity of the sludge and the type of control.
****

Sludge pumps shall be manufactured and installed in accordance with Section 22 13 29 SANITARY SEWERAGE PUMPS.

2.8 ELECTRICAL WORK

2.8.1 General

Electrical equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and shall conform to NFPA 70. Circuit installation shall be in accordance with Sections 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION and 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.8.2 Electric Motors

****
NOTE: Electrical motor driven equipment should be provided complete with motors, motor starters, and controls.
****

Provide for each motor a circuit breaker type combination motor circuit protector, complete with properly sized thermal overload protection on

each phase, along with a hand-off-automatic (HOA) selector switch; red and green pilot lights; manual reset pushbutton; and all other appurtenances necessary for the motor control specified. Each motor shall be of sufficient capacity to drive the equipment at the specified capacity at or below a 1.0 service factor and without exceeding the nameplate rating of the motor when operating at the specified electrical system voltage and frequency. Each electric motor-driven piece of equipment shall be driven by a chemical/mill duty, [explosion-proof] [totally-enclosed fan cooled (TEFC)] [totally-enclosed non-ventilating (TENV)] [_____] motor rated for continuous duty at a 40 degrees C ambient temperature. Motor shall have a [1.15] [1.0] [_____] service factor. All motors shall conform to the respective sections of NEMA MG 1. Three phase motors shall be squirrel-cage induction type having normal-starting-torque and low-starting-current characteristics. Motors shall have sufficient power and torque so that the nameplate power rating, without consideration of the service factor, shall not be exceeded under any operating condition. Adequate thrust bearings shall be provided in the motor to handle any thrust forces that are transmitted to motor under any operating condition. Three phase motors shall be rated 230/460 volts, 60 hertz. Fractional horsepower motors shall be 115 volts, 60 hertz. All motor nameplate information shall be stamped on the attached nameplate in accordance with the requirements of NEMA MG 1. Motors shall have a premium efficiency design, class F insulation, automatic thermal protection of the stator windings, and standard NEMA frame ratings.

2.9 INSTRUMENTATION AND CONTROL

****

NOTE: Instrumentation and control systems are used in water treatment to ensure consistent quality, to optimize process reliability, to assist operating personnel in monitoring process operations, and to minimize operating costs. The measurement and control instruments may range from a simple control panel indicator to a complex, multi-component, programmable logic controller based system.

In developing the scope of the instrumentation and control system design, the designer should consider the following parameters: size of the plant, type and complexity of the treatment process, type of vendor-supplied controls, amount of funds available, current design standards, discharge compliance criteria, special interfaces with other control systems, and the ability of the owner to properly maintain a control system. Generally, the designs of P/C/F systems incorporating manual operation would be limited to batch processes in which the control of pumps and chemical addition is accomplished by operator action. The continuous operation of P/C/F systems usually involves more complex control schemes. Chemical addition can be manually or automatically proportioned to flow and/or to other process feedback signals generated by process instrumentation. The degree of automation incorporated into the system design generally depends upon the complexity of the treatment system, the remoteness of the site, the planned level of operator attention, and the

duration of the project. Systems designed for unattended operation would require the greatest degree of automated system controls. Control schemes may include the use of remotely located programmable logic controllers, remote data telemetry, and telecommunication systems.

The designer should consider how the P/C/F system will be operated for each site-specific application. The equipment used in a P/C/F system can be supplied to operate either in a batch or a continuous mode of operation. A batch operation may be more economical than continuous operation when wastewater flows are small (less than 0.6 L/s 10 gpm), or are intermittent from sources such as a small landfill leachate recovery system or small ground water pumping wells. When the wastewater flows are larger than 0.6 L/s 10 gpm, continuous operation should be used. In the continuous mode of operation, all equipment would run uninterrupted and the wastewater would be fed to the system at a controlled rate.

If a batch operation is used, the designer must decide whether treatment can be performed in one single tank or if multiple tanks are required. In a single tank, the required chemicals for precipitation, coagulation, and flocculation are added sequentially to the same tank at a mixing intensity appropriate for the chemical being added. Following chemical addition, all mixers would shut down to allow a quiescent time for settling to occur. The settled sludge on the bottom of the tank could be drawn off and the supernatant adjusted for final pH. The water can be stored in this one tank until it is analyzed and discharged, or a separate tank can be used to store the water. This type of system is appropriate for sites that generate small amounts of water where the time to treat one batch does not exceed the time to generate a volume of water to be treated. A flow equalization tank must be provided to receive the water while treatment is occurring in the batch tanks.

Alternatively, if more frequent treatment is required, batch treatment can employ multiple tanks where one volume of water is pumped sequentially through the precipitation, coagulation, flocculation, and clarification tanks. The equipment used in this system would be the same as for a continuous operation, except that the instrumentation and controls would be designed to allow intermittent pumping, mixing, and chemical addition rather than continuous. In either mode of operation, the controls can be designed to operate the system with 1) manual control, 2) semiautomatic control, or 3) automatic control. The designer must select the control scheme appropriate for the site considering the complexity of the system and

personnel availability.

In manual control, the operator will start only one process at a time (e.g., precipitation, coagulation, flocculation, clarification, etc.) and check the results of each before starting next operation. In semiautomatic control, the operator must be present to start the P/C/F system and transition from one process to another will be controlled automatically using either an electronic or pneumatic distributed control system. In automatic control, the entire system will operated without an operator. The normal running of the system is linked to one or more governing factors (tank level, flow rate, etc.) which will start up each system when set points are reached. Maximum reliability of a fully automated system can be obtained by using a logic control system which checks that the orders given have been received and carried out and, if not, stops the operations and alarms the operator. All controls should have manual override.

****

The instrumentation and control system shall be [batch] [on-off in response to influent flow] [manual] [semi-automatic] [automatic] [_____] with complete electrical power, control and instrumentation as specified or recommended by the equipment manufacturer for the safe operation and supervision of the P/C/F system. The instrumentation and control package for the P/C/F system shall be supplied as indicated on the drawings. Probes for pH and oxidation reduction potential (ORP), measuring devices, and level sensors specified in the following four subparagraphs shall be of materials resistant to chemical attack over a pH range of 2 to 12, and suitable for a temperature range from [0 to 100] [_____] degrees C [32 to 212] [_____] degrees F and for the liquid to be monitored. All enclosures for pH, flow, and level sensors and transmitters shall be rated NEMA 4X.

2.9.1 pH Monitoring/Control

pH probes shall be provided [where indicated on drawings] [on the effluent line of each reactor] for the purposes of pH monitoring and/or pH control through an associated control device (PLC, single loop controller, etc.). Probes shall be easily removable without interrupting service. Probe materials shall be resistant to operating pressures of up to [_____] kPa psi. The probes shall be interconnected to associated transmitters/indicators that are located preferably in the main control panel. Probes shall be connected to a micro processor based pH analyzer having a 4 digit readout with 38 mm 1-1/2 inch high letters and an isolated 4 - 20 mA DC output signal proportional to the pH. The accuracy of the pH unit shall be plus or minus 0.5 percent of full scale.

2.9.2 ORP Monitoring/Control

An oxidation reduction potential (ORP) probe shall be provided [where indicated on drawings] [_____] for the purpose of ORP monitoring and/or control. Probe shall be easily removable without interrupting service. Probe materials shall be resistant to operating pressures of up to [_____] kPa psi. The probes shall be interconnected to associated transmitters/indicators that are located preferably in the main control panel. Probe shall be connected to a micro processor based pH analyzer

having a 4 digit readout with 38 mm 1-1/2 inch high letters and an isolated 4 - 20 mA DC output signal proportional to the ORP. The accuracy of the ORP unit shall be plus or minus 0.5 percent of full scale.

2.9.3 Flow Monitoring/Control

Flow measuring devices shall be provided [where indicated on drawings] [on the influent line] [on the effluent line] for the purpose of flow monitoring and/or control. Measuring devices shall be easy to maintain without interrupting service. Measuring devices shall be resistant to operating pressures of up to [_____] kPa psi. Measuring devices shall be connected to a microprocessor based flow analyzer having a digital readout with 38 mm 1-1/2 inch high letters and an isolated 4 - 20 mA DC output signal proportional to the flow. The accuracy of the flow monitoring unit shall be plus or minus 0.5 percent of full scale. The type of flow meter selected shall be fully coordinated with the application involved as shown on the drawings to assure that the flow meter meets all installation and operational criteria (upstream and downstream distances from appurtenances, minimum and maximum flow velocities, degree of required accuracy, full pipe flow, etc.).

2.9.4 Level Monitoring/Control

Level indicator gauges of the direct-reading type, equipped with a shutoff valve, shall be provided on the discharge side of the tank. Gauges shall have 150 mm 6 inch dials, shall be stem mounted, and shall conform to ASME B40.100. Accuracy of gauges shall be Grade A in accordance with ASME B40.100. Gauges shall be calibrated in kPa and psi psi in not more than 10 kPa and 2 psi 2 psi increments from 0 to 350 kPa and 0 to 50 psi 0 to 50 psi in excess of the normal operating pressure at the tank. All level (float) switches shall be mechanically actuated with Form C contacts. All electronic level sensing devices shall include a sending unit that transmits an analog or discrete signal, as required for the application, to an associated control panel or control device. Level monitoring/control sensors shall be provided [where indicated on drawings] [_____]. Sensors shall be easily removable without interrupting service. All analog level sensor shall be connected to a microprocessor based level indicator and/or controller as required by the application having a 4 digit readout with 38 mm 1-1/2 inch high letters and an isolated 4 - 20 mA DC output signal proportional to the level to be measured.

2.9.5 Control System

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NOTE: The designer should include a detailed operating and control procedure in this paragraph to explain the control philosophy for each component of the P/C/F system. This operating and control procedure should include all information required for system start-up, continuous operations, and normal and emergency shut-down operations. This procedure should include all operating set points for pump starting/stopping/alarming/shutdown, all normal/alarm/shutdown pH values, all normal/alarm/shutdown ORP values, all normal/alarm/shutdown liquid levels, as well as all other normal/alarm/shutdown values for any other control or processing equipment. This procedure should delineate all normal operational values for

each component of the P/C/F system.
****

Design the control system to operate as shown on the drawings and described in the operating and control procedures provided [below] [as an attachment]. All alarms and/or shutdowns shall consist of both visible alarm lights and audible alarm signals on either the main control panel, or on a remote microprocessor controller screen. The alarms and shutdowns shall function through a first-out-sequence annunciation. Alarms shall be provided for high and low water and chemical levels, high and low pH values, and high and low ORP values. Automatic shutdowns shall be provided for each system when a control value or an operational system ranges out of normal operational limits where personnel safety is a concern, where mechanical damage can occur to process equipment, or where the process excursion has the potential to violate discharge water quality criteria; such shutdowns can occur for both high and low conditions. Power failures and equipment failures shall initiate an alarm as well as an orderly and automatic shutdown of the treatment system. [Auto-dialing to an indicated remote location shall be provided to report each alarm or shutdown that stops the movement of process water through the treatment system or stops chemical feed systems. The Contractor is responsible for providing the associated telephone line for the auto-dialer system.] Control power transformers, relays, adjustable timers, auxiliary contacts, switches, or additional equipment required to interconnect the treatment equipment to a monitoring/control system shall be provided. Conduit and wiring between control panels, treatment components, and all control devices shall be furnished.

2.9.6 Control Panel Enclosures

All required control panels for the control system shall be rated NEMA 4X [fiberglass] [stainless steel] and shall be sized to assure that adequate internal space is available for all components specified and/or required with an allowance of no less than 30 percent spare space. To the greatest extent possible all instrument transmitters shall be installed in or adjacent to the control panel enclosure.

2.10 STRUCTURAL SKIDS

Where a P/C/F system has structural skids, skids shall be fabricated in accordance with Section 05 12 00 STRUCTURAL STEEL. Submit shop details for each structural skid including members (with their connections) not shown on the drawings. Welds shall be indicated by standard welding symbols in accordance with AWS A2.4.

2.11 PAINT/COATINGS

****
NOTE: UFGS 09 97 02 is a guide specification developed for Civil Works projects.
****

Paint and coatings work shall be in accordance with Sections 09 90 00 PAINTS AND COATINGS[and 09 97 02 PAINTING: HYDRAULIC STRUCTURES].

2.12 INSULATION/HEATING/VENTILATION

****
NOTE: In cold climates, exposed pipe, valves, pumps

and equipment should be insulated and/or heat traced to prevent freezing. Tanks should be insulated and heated to keep the tank contents above freezing temperatures.
****

Provide insulation for pipes, valves, pumps, tanks, instrumentation and controls, and other equipment in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.13 NAMEPLATES

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.14 SPECIAL TOOLS

One set of special tools, calibration devices, and instruments required for operation, calibration and maintenance of the equipment shall be provided, as recommended by the manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

****
NOTE: The designer will determine if the examination by the Contracting Officer is to apply to all equipment or only to special items to be inspected.
****

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before work begins. After equipment is delivered to the site and prior to installation, examine the treatment plant equipment for any damage, defect, or deterioration and verify that all construction equipment used at the site is of sufficient capacity and in good mechanical condition. Results of this pre-installation examination shall be documented and submitted to the Contracting Officer for review.[Contracting Officer will also conduct this examination independently.] Based on the examination, the Contracting Officer has the right to reject damaged, defective, or deteriorated equipment. Surface damage to equipment shall be corrected according to the manufacturer's requirements. Costs associated with the delay caused by the rejection shall be borne by the Contractor. All specified preconstruction submittals shall be provided to the Contracting Officer.

3.2 INSTALLATION

Equipment shall be handled with extreme care to prevent damage during placement. Equipment shall be installed, except as otherwise specified, as indicated on the drawings, and in accordance with the manufacturer's written instructions [and under direct supervision of the manufacturer's representative] [_____]. Installation shall include furnishing all materials required for initial operation. Equipment shall be properly leveled, aligned, and anchored in place in accordance with the manufacturer's instructions. Supports shall be provided for equipment,

appurtenances, and pipes as required. Piping runs shall be straight and evenly supported. Valves shall be installed with stems horizontal or above the pipe centerline. Flanges and unions shall be installed where valve and equipment maintenance may require disassembly. P/C/F system shall be provided complete and ready for operation. Plumbing work shall conform to the requirements of [Section 22 00 00 PLUMBING, GENERAL PURPOSE] [_____].

3.2.1 Foundations

Foundations for tanks, clarifier, and other equipment shall be constructed of reinforced concrete, except as shown or specified herein.

3.2.2 Excavating, Filling, and Grading

Excavating, filling, and grading shall conform to the applicable requirements of Section 31 00 00 EARTHWORK.

3.2.3 Cathodic Protection

Cathodic protection shall be provided on steel tanks and clarifiers, conforming to Section 26 42 15.00 10 CATHODIC PROTECTION SYSTEM (STEEL WATER TANKS).

3.2.4 Welding

Tank welding shall be performed in accordance with [Section 8 of AWWA D100] [AWWA D103] [API Std 650].

3.2.5 Erection

Tank erection shall be performed in accordance with [Section 10 of AWWA D100] [AWWA D103] [API Std 650].

3.2.6 Field Painting

****
NOTE: UFGS Section 09 97 02 is a guide specification developed for Civil Works projects.
****

Painting shall be in accordance with Sections 09 90 00 PAINTS AND COATINGS[and 09 97 02 PAINTING: HYDRAULIC STRUCTURES]. Stainless steel, galvanized steel, and nonferrous surfaces shall not be painted.

3.2.7 Inspections and Testing

Tank inspection and testing shall be in accordance with Section 11 of AWWA D100. Mill and shop inspections [are not required] [are required and shall be performed by an approved commercial inspection agency]. Contractor shall perform the hydrostatic test. Final hydrostatic test shall be performed before painting.

3.2.8 Radiographic Inspection and Testing

Tank radiographic inspection and testing shall be in accordance with Section 11 of AWWA D100. Radiographic inspections [are not required] [are required and shall be performed by an approved commercial inspection agency]. All testing shall be performed before painting.

3.3 FIELD QUALITY CONTROL

3.3.1 Inspection

****

NOTE: The system's P&ID and the as-built drawings are used to verify that all equipment, piping, and valves are installed according to plans and specifications. The electrical one-line diagrams and wiring diagrams are useful to verify the electrical and instrumentation systems. Grounding of equipment should also be inspected. Vendor's certified shop drawings and equipment operating manuals should be used to check the equipment installation and operation.

****

After the installation is complete, each component will be inspected by the Contracting Officer to verify that the components of the system are properly installed according to drawings and specifications. Any discrepancies found shall be corrected and work affected by such deficiencies shall be at the Contractor's expense.

3.3.2 Tests

Each piece of equipment shall be subject to an operational test, under the supervision of a factory representative and may be observed by the Contracting Officer. Test shall demonstrate that the equipment is not defective and is in safe and satisfactory operating condition. Notify the Contracting Officer [7] [_____] days prior to the dates and times for acceptance tests. Each unit shall be given a running field test in the presence of the Contracting Officer for a minimum of [2] [_____] hours. If any deficiencies are revealed during the tests, such deficiencies shall be corrected by the manufacturer and the tests shall be repeated. Submit Test Reports in booklet form showing field tests performed to adjust each component and to prove compliance with the specified performance criteria upon completion and testing of the installed system. Test methods used shall be identified and test results shall be recorded. Each test report shall indicate the final set point of each control device. Test reports shall be provided for pre-startup testing and startup performance testing; also include test reports showing the results of factory tests performed.

3.3.3 Manufacturer's Service

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. Representative shall supervise the installation, adjustment, and testing of the equipment. Up to [5] [7] [10] [_____] days of service shall be provided.

3.4 STARTUP AND OPERATION

****

NOTE: Pre-start-up procedures should be provided for each component of the P/C/F system and procedures should be provided for start-up of the whole system. The startup plan must include pre-startup checkouts, pre-startup testing, and the

actual startup. The following sections describe startup operations of a P/C/F treatment system. The startup procedure follows a planned sequence of events for each component of the system.
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3.4.1 Hydrostatic Tests

****
NOTE: The test pressure should not exceed 130 percent of the rated pressure. Testing of pipe and fittings should be specified in the same section where the pipe is specified in.
****

After installation, all tanks shall be tested for leaks or damage in shipment. The tanks shall be hydrostatically tested [to [_____] kPa psig] [as indicated in the schedule] or 1.5 times the system operating pressure, whichever is greater. The tanks shall be tested for a period of [24] [_____] hours. Furnish testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, and all labor required. Damage or leaks in tanks shall be repaired or tanks shall be replaced at the Contractors expense. Joints of air lines shall be tested using a soapy water solution to detect leaks.

3.4.2 Pre-startup Checkout

****
NOTE: The pre-startup checkouts are designed to verify the integrity of the system components prior to pre-startup testing.
****

Components subjected to the pre-startup checkout shall include the following items:

a. Foundations shall be checked to verify that they are placed and sealed properly;

b. System shall be checked to verify that all equipment has been properly installed and connected;

c. Rotating equipment which requires lubrication shall be checked to ensure that manufacturer's procedures have been followed;

d. Equipment shall be level and checked for proper alignment, anchored, and static ground wires installed;

e. Piping, flange bolts, gaskets, and hoses shall be checked to ensure that connections are tight, and flushed clean;

f. Valves shall be checked for position and operability and flushed clean;

g. Electrical wiring and lighting shall be checked to verify that wiring has been completed correctly;

h. Continuity checks shall be performed on wiring loops;

i. High/Low liquid level alarms on tanks, as well as pump on/off level

controls, shall be checked for proper installation and response;

j. Chemical feed systems shall be checked for proper installation;

k. Chemicals shall be checked for proper type, required quantity and mixing; tanks shall be filled;

l. Lockout devices and site security devices shall be checked for proper installation.

3.4.3 Pre-startup Testing

****

NOTE: The pre-startup testing of the system should be performed to verify the integrity of each component and of the whole system prior to actual startup.

****

Each component of the system shall be subjected to the pre-startup testing as described below:

a. Piping and hoses transporting liquid shall be pressure tested on clean water for at least one hour, with no loss of pressure at 1.5 times the working pressure; tanks shall be pressure tested at the maximum hydraulic head using clean water;

b. Electrical wiring shall be tested to verify that there is no wiring damage or deterioration that could cause injury to personnel or damage to equipment;

c. Power shall be turned on to test equipment and control systems only after the electrical systems are tested and certified ready for operation;

d. Lighting shall be tested and put in service to support work in all areas of the plant;

e. Rotating equipment such as pumps, mixers, and blowers, if used, shall be tested for correct direction of rotation by bumping the starter manually;

f. Each pump shall be operated for a minimum of [4] [_____] continual hours at operating or test conditions. Tests shall assure that the units, controls and instrumentation have been installed correctly, and that there is no over-heating, vibration or excessive noise;

g. Depending on the complexity of the control system, testing can proceed from this point to verify that manual and automatic controls function properly and control valves open/close. All tanks shall be filled and emptied to determine if high and low level alarms sound at the prescribed liquid level;

h. Safety shutdown sequences, controls/alarms and interlocks in the control system shall be tested to ensure that they are installed properly and functioning as intended;

i. Each emergency shutoff switch shall be clearly labeled and tested to determine that it works properly;

j. Electrical "lockout" devices with padlocks shall be tested to ensure that power has been disconnected;

k. Instrumentation shall be calibrated before systems are put into service. Pressure and temperature gauges shall be tested against standardized gauges. Where NIST SP 250 calibration standards exist, they shall be utilized.

3.4.4 Startup Performance Testing

****

NOTE: The startup check and functional performance tests should be performed in accordance with the manufacturer's recommended procedures. The startup should proceed following a startup plan prepared well in advance. Performance testing begins with equipment or components, proceeds through systems, and ends with the complete treatment system passing its performance specifications and contractual requirements testing.

****

Startup testing shall not be initiated until after each component of the system has been demonstrated to meet the requirements of the pre-startup testing and until written approval has been received from the Contracting Officer. Once steady state operation is achieved, a functional performance test shall be performed as described in the following startup checklist:

a. Check flow rates, pH, and contaminant levels of the wastewater feeding the reactor tank;

b. Check pump operating points to verify that the actual operating point matches the pump curve specification for flow and pressure;

c. Start/stop pumps from all control mechanisms;

d. Check that current draw and voltage balance match specifications for all phases;

e. Check the reagent feeding systems to verify that the actual chemical feed rate is within the specified accuracy range;

f. Check the pH in the reactor to verify that operating values are within the design range;

g. Adjust the reagent feed rates, and the pH control system as required to achieve maximum metal removals;

h. Monitor the composition of the effluent to verify that it meets the specified performance requirements.

i. Check the clarifier overflow rate to verify that it is within the design range;

j. Check the sludge collecting device to verify that it is operating properly, and no sludge is overflowing the weir;

k. Check the control system to verify that the system operates within set parameters; and

l. Check the monitoring systems and instruments to verify that they hold calibration.

m. A successful performance test shall include [48] [_____] hours of operation processing water from the design influent source at design capacity and meeting effluent requirements with less than 20 percent down time. Any deficiencies shall be corrected and performance checks successfully completed before the system will be accepted. Equipment not capable of performing as specified shall be replaced or upgraded at no additional cost. Submit Proof of Performance and Equipment Certificate of Conformance as specified. Submit a list of the proposed operating conditions for process parameters to be continuously monitored and recorded. Include detailed descriptions of the proof of performance schedule, operating conditions and parameters, influent sources, and required sampling and analyses.

3.4.5 Field Training

****

NOTE: The field training provided by the Contractor must be modified if the process will be operated by the Contractor for the first year.

****

Upon completion of the installation and at a time designated by the Contracting Officer, conduct a field training course for a representative of the Government in the operation and maintenance of equipment furnished under the contract. These field instructions shall cover all the items contained in the operation and maintenance instructions. Training shall be provided for a total period of [8] [16] [_____] hours per day for a period of [5] [_____] days of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field instructions shall cover the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. A video tape of the field training course shall be prepared as a permanent record for future training use.

3.4.6 Operation and Maintenance Manual Updates

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NOTE: The O&M Manual is intended for use by operating personnel and should be adapted to the particular features of the equipment installed; therefore, the document must be written for the operator.

****

The O&M manual shall include the following:

a. General description of the treatment process;

b. A detailed description of equipment;

c. Process flow diagram;

d. Piping and instrumentation diagrams;

e. Certified drawings for equipment components and equipment layout;

f. Practical operating procedures including performance testing, influent, and effluent concentrations, and trend analysis of influent;

g. A complete set of fully updated and annotated piping and instrument diagrams, process flow diagrams, instrument indexes, control ladder logic diagrams, description of controls, alarms, interlocks, instrument interface, and maintenance procedures;

h. Specialty items such as type of oil and grease, desiccants, tools, analytical instruments, etc.;

i. Initial startup procedures;

j. Emergency and scheduled shutdown procedures;

k. Monitoring and quality control, spill controls;

l. Equipment specifications;

m. A list of modes of failure for each piece of equipment;

n. Fault/failure analysis, and trouble shooting guide;

o. List of spare parts;

p. Process safety and protective equipment requirements; and

q. Record keeping (electronic or other) requirements.

In order to plan all the inspection and maintenance operations required for plant operation, a maintenance schedule shall be provided. The maintenance schedule shall include:

a. Scheduled maintenance procedure for each piece of equipment;

b. Sensor and measurement device calibration frequency;

c. Periodic reports regarding consumption of chemicals such as acid, caustic, polymer, and coagulants;

d. Electronic or other recording data;

e. Personnel training requirements;

f. The time required for each maintenance task;

g. Equipment shutdown and lock and tag requirements during maintenance/repair; and

h. Mothballing and preservation procedures for equipment layaway.

The entire schedule and the results of each task shall be recorded for future analysis. Other items shall be included as follows:

a. Spare parts list with suppliers and costs;

b. Plant utility requirements such as electrical, air, drinking water, service water, telephone, and sewer;

c. Detailed safety procedures for chemical handling; and

d. Name, address, and telephone number of technical personnel to contact in case of an emergency related to the treatment system.

Final acceptance of the P/C/F system will not be given until these documents have been supplied, reviewed, and approved.

3.4.7 System Operation by Contractor

The first period of operation shall not be initiated until after the Contractor has successful completed all work and received written approval from the Contracting Officer. Continue to operate the system for a period of [30 days] [6 months] [1 year] [_____] being responsible for operations, process monitoring, maintenance, chemical testing, and record keeping during operation in conformance with this specification.

3.5 SPARE PARTS

Submit a list of spare parts with the manufacturer's part number, a current unit price and source of supply for each different material or equipment specified, after approval of the related submittals and not later than [_____] months prior to the system startup. The list shall include: 1) parts recommended by the manufacturer to be replaced during the first [_____] years of service, 2) a list of special tools recommended by the manufacturer for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly and 3) spare parts data for each different item of equipment and materials specified.

-- End of Section --