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USACE / NAVFAC / AFCEC / NASA | **UFGS-46 07 13.13 (May 2021)**

Preparing Activity: USACE | **Superseding UFGS-02 51 13 (May 2010)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2021

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DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 07 13.13

PRECIPITATION/COAGULATION/FLOCCULATION (P/C/F) WATER TREATMENT

05/21

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SECTION 46 07 13.13

PRECIPITATION/COAGULATION/FLOCCULATION (P/C/F) WATER TREATMENT
05/21

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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)**.**

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PART 1 GENERAL

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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.

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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	(2017) Minimum Design Loads 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	(2019) 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 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[, [_____]]

Design Submittal

SD-03 Product Data

Tanks; G[, [_____]]

Mixers; G[, [_____]]

Clarifiers; G[, [_____]]

Instrumentation and Control; G[, [_____]]

Spare Parts

Regulatory Requirements

Pre-startup Testing; 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

1.3 QUALITY CONTROL

****

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.

****

1.3.1 Regulatory Requirements

Obtain all permits, certifications, and/or meet the regulatory requirements necessary for the configuration, installation, startup, and operation of the treatment plant. Ensure all work meets or exceeds 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. Transport, store and handle equipment, raw materials (including reagents/additives), contaminated materials, and treated materials 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.

1.3.2 Qualifications

Contractor and Subcontractors 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 are required to have a minimum of [_____] years' experience in the installation and operation of similar treatment systems and show evidence of satisfactory operation for each installation. Welding procedures and welders are required to 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.

1.4 DELIVERY, STORAGE, AND HANDLING

Store and protect from inclement weather, excessive humidity and temperature variation, and dirt, dust or other contaminants, per the recommendations of the equipment manufacturer. The government is not responsible for damage caused by improperly storing materials.

1.5 SITE CONDITIONS

1.5.1 Ambient Conditions

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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.

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Ensure the P/C/F system is [operated continuously] [not operated] [_____] during the winter when temperatures reach freezing or below. Install the system [outdoors] [indoors] [_____]. Provide outdoor equipment with [insulation] [_____] and [heat tracing] [_____]. Ensure the system is 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.

1.5.2 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.
****

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

1.6.1 Spare Parts

Submit a list of spare parts with the manufacturer's part number, a current unit price, [date of manufacturer] 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. Include the following information on: 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. At least two (2) sources of supply are suggested to be submitted.

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.
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2.1 SYSTEM DESCRIPTION

2.1.1 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 is required to be a fully integrated water treatment plant which is designed to remove dissolved heavy metals and solids from [groundwater] [and] [landfill leachate] [_____]. The system is required to 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. Provide the P/C/F system complete with required instruments, controls, and local control panels. Provide a main control center to facilitate the overall control of the treatment plant. Factory or shop preassembled all parts to the maximum extent possible, compatible with transportation limitations and equipment protection considerations. Minimize field assembly 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.

2.1.1.1 Equalization Unit

Provide the equalization unit with [one tank] [[_____] tanks] complete with accessories, mixers, piping, valves, [pumps,] motors, and instrumentation and controls to provide a constant flow and contaminant concentration to the subsequent treatment equipment. Furnish components of the unit as shown on the drawings.

2.1.1.2 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).

****

[Provide the reduction unit with 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.] [Provide the oxidation unit with 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.]

2.1.1.3 Precipitation Unit

Provide the precipitation unit with 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.

2.1.1.4 Coagulation Unit

Provide the coagulation unit with 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.

2.1.1.5 Flocculation Unit

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

2.1.1.6 Clarification Unit

Provide the clarification unit with 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.

2.1.1.7 Post-pH Adjustment Unit

Provide the post-pH adjustment unit complete with piping, chemical feed systems for both acid and base addition, and in-line pH instrumentation and controls as indicated on the drawings.

2.1.1.8 Effluent Holding Unit

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

2.1.2 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 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

Provide a P/C/F system 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	[_____]	[_____]
TDS	[_____]	[_____]

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

2.1.3 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.

2.1.4 Utilities

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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.

2.1.5 Design Submittal

Submit the following items:

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 properly functions as part of the overall P/C/F system. Show proposed layout, foundation requirements (to include seismic considerations in seismically active areas and soils assumptions based on site specific geotechnical information), 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. Coordinate all control ladder logic diagrams between components and ladder rungs to illustrate component tag names for all relays, timers, selector switches, pushbuttons, pilot lights, etc. Number tag wires and terminals. Distinguish terminal designations between terminals contained within differing enclosures such as control panels, equipment enclosures, motor control centers, etc. Ensure all auxiliary relay contacts are illustrated and designated. Number all ladder rungs with cross referencing between all associated rungs. Provide a narrative description that has been 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. Designate the locations of all control panels, equipment enclosures, motor control centers, etc. 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 used to verify the integrity, calibration, and operability of the equipment, piping, electrical wiring, and instruments and control systems. Specify acceptance criteria and tolerances to be achieved during the pre-startup testing within the plan.

d. A list of the P/C/F system components and specify its required performance criteria when operated using contaminated water. Ensure the test plan describes 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. Address full-scale operation of all equipment, piping, electrical wiring, and instruments and control systems included in the P/C/F system within the plan.

e. Manufacturer's certificates attesting that the equipment meets the specified requirements. Date the statement after the award of the contract, state the Contractor's name and address, name the project and location, and list the specific requirements which are being certified. Ensure the certificate indicates 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, piping supports, 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 to 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 to take to correct anticipated problems that may occur in the system.

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

2.2 MANUFACTURED UNITS

2.2.1 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. Provide new and unused equipment, except for test equipment. Where two or more pieces of equipment performing the same function are required, they are required to be products of the same manufacturer. Equipment is required to 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.

2.2.2 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 properly function as a part of the overall P/C/F system. On the drawings, show the 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.

2.2.2.1 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 are required to be compatible with the wastewater to be stored. Select tank dimensions to fit the available space as shown on the drawings. Unless noted otherwise on the drawings, include flanged fittings for inlet, outlet, overflow, and drain on each tank. Provide manholes when shown on the drawings. Provide hold down lugs to anchor the tank to the base. Provide influent and effluent baffles and weirs to avoid short circuiting. Ensure the tank geometry combined with mixer design to avoid dead spots and excessive turbulence relative to internal tank baffles and mixer orientation. Ensure the system provides for complete mixing. Tanks supplied as part of the P/C/F system are required to 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 in accordance with [AWWA D100] [API Std 650] [AWWA D103] except as modified herein. Minimum equipment design life: [_____] years. Design tanks for a [basic wind speed of [_____] km/hour mph in accordance with ASCE 7 or designed in accordance with [AWWA D100] [AWWA D103] [API Std 650] wind load design, whichever provides the greater pressure.] [snow load of [1200 Pa25 psf] [[_____] kPa psf]][freeboard of [03m1 ft][___].] Utilize a safety on overturning of elevated tanks under design wind load of 1.33 minimum. When a footing is required, use an inverted truncated pyramid of earth with 2 on 1 side slopes above top of footing in determining overturning stability.

2.2.2.2 Tank Construction Materials

****
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.
****

2.2.2.2.1 Carbon Steel

Carbon steel sheet is required to be hot rolled in accordance with ASTM A283/A283M Grade C with a minimum yield of 476 MPa 40,000 psi; use a minimum thickness of 3.4 mm 10 gauge. Ensure structural steel conforms to ASTM A36/A36M and [AWWA D100] [AWWA D103] [API Std 650] for steel tanks.

2.2.2.2.2 Polyethylene

Provide polyethylene tanks manufactured in accordance with ASTM C582.

2.2.2.2.3 Stainless Steel

Ensure stainless steel conforms to the material specification for 304SS, 316SS, 316LSS, 317SS.

2.2.2.2.4 Structural Steel

Ensure structural steel conform to ASTM A36/A36M.

2.2.2.2.5 Fiberglass

Provide fiberglass tanks in conformance with ASTM D3299.

2.2.2.3 Corrosion Allowance

****

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.

****

Corrosion allowance is dependent upon the materials of construction and finish coatings. Corrosion allowances are to be calculated as follows: For a lined interior finish, corrosion allowances are allowed to be [0.0 mm 0.0 inches] [_____]. For a coated or painted interior finish, the corrosion allowance is allowed to be [0.0 mm 0.0 inches] [_____]. For tanks with no protective finish, the corrosion finish is required to be [0.0 mm 0.0 inches] [_____].

2.2.2.4 Shop Fabrication

Perform all welding in conformance with [AWWA D100] [AWWA D103] [API Std 650] using ASME certified welders. Ensure all shell seams are full penetration using Sub Arc Welding (SAW). Ensure other seams are made with [Gas Metal Arc Welding (GMAC)] [Shielded Metal Arc Welding (SMAC)] [Flux Cored Arc Welding (FCAW)] [Submerged Arc Welding] processes.

2.2.2.5 Bolts

Bolts used in the shell joints are required to meet the requirements of

Section 2.2 of AWWA D103. Bolts used in tanks designed under [AWWA D100] [API Std 650] are required to meet the requirements as specified in [AWWA D100] [API Std 650].

2.2.2.6 Gaskets

Ensure all bolted connections use gaskets of suitable chemical resistance for the service. Gaskets used to seal bolted joints in tanks are required to meet the requirements of AWWA D103 Section 2.10.

2.2.2.7 Accessories

2.2.2.7.1 Manholes and Pipe Connections

Manholes and pipe connections are required to meet the minimum requirements of [AWWA D100] [AWWA D103] [API Std 650]. Provide the number, type, elevation, orientation, and size of manholes and pipe connections [as shown on the drawings] [provided by Contractor].

2.2.2.7.2 Baffles, Weirs, and Overflow Pipes

****

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.

****

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

2.2.2.7.3 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).

****

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

2.2.2.7.4 Ladders and Safety Devices

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

2.2.2.7.5 Scaffold and Cable Support

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.

2.2.2.7.6 Miscellaneous Tank Accessories

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

2.2.3 Chemical Feed Systems

****

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.

****

Provide chemical feed systems in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS. Furnish control signals and wiring to the chemical feed controllers in accordance with the requirements of this section.

2.2.4 Mixers

****

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.
****

Furnish mixers 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 properly functions as a unit. Submit manufacturer's descriptive data, specifications, technical literature, utility requirements, performance charts and curves, and catalog cuts for each mixer supplied.

2.2.4.1 Equalization Unit Mixer

****
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 are required to be a [propeller] [turbine] [paddle] [jet] type mixer. Number of mixers: [_____].

a. Ensure propeller, turbine, or paddle mixers meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratios are required to be [4:1] [_____]. Design mixer to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mount mixers [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] [_____]. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Jet mixers are to consist of, but 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. Design jet mixer to obtain a maximum mean velocity of [100] [_____] sec-1 or G(t) values of [104] [_____]. The jet motive pump is to driven by submersible non-clog units. Provide motors that operate on 230/460 volt, three phase, 60 hertz power supply. Provide nozzle assembly and piping made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

2.2.4.2 Precipitation Unit Mixer

Achieve mixing by use of a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Provide propeller or turbine type mixers that meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio is required to be [4:1] [_____]. Design mixer to develop a maximum velocity gradient (G value) not less than [300] [_____] sec-1. Mount mixers [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] [_____]. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Provide jet mixer consisting of, but not 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. Design the jet mixer to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump is required be driven by submersible non-clog units. Provide motors that operate on 230/460 volt, three phase, 60 hertz power supply. Provide nozzle assembly and piping made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

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

2.2.4.3 Coagulation Unit Mixer

Achieve mixing by use of a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Propeller or turbine mixers are required to meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio is required to be [4:1] [_____]. Design mixer to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mount mixers [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] [_____]. [Provide][Do not provide] the mixer support with the mixer. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Jet mixers consist of, but are 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. Design jet mixer to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump is to be driven by submersible non-clog units. Provide motors that operate on 230/460 volt, three phase, 60 hertz power supply. Provide nozzle assembly and piping made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

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

2.2.4.4 Flocculation Unit Mixer

Provide mixers that are [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 is required to be [4:1] [_____]. Design mixer to develop a maximum velocity gradient (G value) no more than [100] [_____] sec-1. Mount mixers [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] [_____]. [Provide][Do not provide] mixer support. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

2.2.4.5 Effluent Holding Unit Mixer

Achieve mixing by use of a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Provide propeller or turbine mixers meeting the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio is required to be [4:1] [_____]. Design mixer to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mount mixers [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] [_____]. [Include][Do not include] mixer support. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Provide jet mixers consisting of, but not 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. Design jet mixer to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump is to be driven by submersible non-clog units. Provide motors that operate on 230/460 volt, three phase, 60 hertz power supply. Provide nozzle assembly and piping made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

2.2.5 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 is required to be an inclined [plate] [or] [tube] settler designed to meet the following conditions:

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

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

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

Provide for an effective surface overflow rate of [_____] L/m3/m2.s gpd/ft2 and a detention time of [2] [_____] hours at the design flow rate. Clarifiers are required to include, 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.

2.2.5.1 Clarifier Vessel

Construct the bottom and sides of the clarifier vessel 6 mm 1/4 inch minimum thickness carbon steel plate meeting or exceeding ASTM A36/A36M. Provide the vessel complete with inlet, outlet, overflow, and drain connections. The structural steel framework is an integral part of the vessel to ensure it is self-supporting. Design the clarifier for seismic forces in accordance with paragraph Existing Conditions.

2.2.5.2 Influent Distribution and Effluent Collection Systems

The influent distribution system dissipates the entrance energy and equalizes flow to the separator module. Include weirs and baffles to control the local velocities and eliminate short circuiting. Use adjustable weirs along each effluent collection flume to maintain uniform flow distribution.

2.2.5.3 Separator Module

Construct the separator module using [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 is required to be constructed to be removable for maintenance and inspection. Construct the separator module with corrosion resistant materials. Provide [corrugated plate packs] [tube packs] constructed of [fiberglass reinforced plastic] [polypropylene] [coated steel] [stainless steel] [_____].

2.2.5.4 Skimmer and Sludge Collection/Thickening Devices

The mechanical skimmer and drive is required to continuously collect floating scum and remove it to a collection trough. Equip the sludge holding compartment with a hopper bottom having sides tapering downward at an angle not less than [55] [_____] degrees above horizontal for sludge collection. The sludge hopper is to be mounted in a [fixed] [removable] [_____] position and be equipped with a vibrator pack for sludge thickening. Size the sludge hopper to provide a minimum of [_____] L gallons of sludge storage. Provide a flanged outlet for each hopper which connects to a pump for sludge removal.

2.2.5.5 Miscellaneous

Supply the clarifier with a steel platform around the perimeter complete with ladder, handrail, and toe plates. Paint in conformance with Sections 09 90 00 PAINTS AND COATINGS and 09 97 02 PAINTING: HYDRAULIC STRUCTURES, unless otherwise indicated.

2.2.6 Piping/Valves

Provide piping and valves for chemical feed in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS. Install low point drains in interconnecting piping.

2.2.7 Pumps

Provide pumps that meet the following requirements. Provide pumps for specific services and accessories per the following specifications.

2.2.7.1 Water Pumps

****
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.
****

Design water pumps in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.2.7.2 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.
****

Manufacture and install chemical metering pumps in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

2.2.7.3 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.
****

Manufacture and install sludge pumps in accordance with Section 22 13 29 SANITARY SEWERAGE PUMPS.

2.2.8 Electrical Equipment

2.2.8.1 General

Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and in conformance with NFPA 70. Install circuits in accordance with Sections 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION and 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.2.8.2 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. Ensure each motor has 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 is required to 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. Provide motor with a [1.15] [1.0] [_____] service factor. Ensure all motors conform to the respective sections of NEMA MG 1. Three phase motors are required to be squirrel-cage induction type having normal-starting-torque and low-starting-current characteristics. Size motors with sufficient power and torque so that the nameplate power rating, without consideration of the service factor, is not exceeded under any operating condition. Provide adequate thrust bearings in the motor to handle any thrust forces that are transmitted to motor under any operating condition. Three phase motors are required to be rated at 230/460 volts, 60 hertz. Fractional horsepower motors are required to be 115 volts, 60 hertz. Stamp all motor nameplate information on the attached nameplate in accordance with the requirements of NEMA MG 1. Supply motors that have a premium efficiency design, class F insulation, automatic thermal protection of the stator windings, and standard NEMA frame ratings.

2.2.9 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.

****

Provide the instrumentation and control system to 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. Supply the instrumentation and control package for the P/C/F system as indicated on the drawings. Ensure the probes for pH and oxidation reduction potential (ORP), measuring devices, and level sensors specified in the following four subparagraphs are made 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 are to be rated NEMA 4X.

2.2.9.1 pH Monitoring/Control

Provide pH probes [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.). Ensure installed probes are easily removable without interrupting service. Provide probe materials that are resistant to operating pressures of up to [_____] kPa psi. Interconnect the probes to associated transmitters/indicators that are located preferably in the main control panel. Connect probes 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. Ensure the accuracy of the pH unit is plus or minus 0.5 percent of full scale.

2.2.9.2 ORP Monitoring/Control

Provide an oxidation reduction potential (ORP) probe [where indicated on drawings] [_____] for the purpose of ORP monitoring and/or control. Install probe so it is easily removable without interrupting service. Supply probe materials that are resistant to operating pressures of up to [_____] kPa psi. Interconnect the probes to associated transmitters/indicators that are located [preferably] in the main control panel. Connect the probe to a microprocessor 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. Ensure the accuracy of the ORP unit is plus or minus 0.5 percent of full scale.

2.2.9.3 Flow Monitoring/Control

Provide flow measuring devices [where indicated on drawings] [on the influent line] [on the effluent line] for the purpose of flow monitoring and/or control. Install measuring devices in a manner that ensures they are easy to maintain without interrupting service. Supply measuring devices that are resistant to operating pressures of up to [_____] kPa psi. Connect measuring devices 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. Ensure the accuracy of the flow monitoring unit provided is plus or minus 0.5 percent of full scale. Coordinate the type of flow meter selected 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.).

2.2.9.4 Level Monitoring/Control

Provide level indicator gauges of the direct-reading type, equipped with a shutoff valve, on the discharge side of the tank. Provide gauges with 150 mm 6 inch dials that are stem mounted and conform to ASME B40.100. Provide gauges with accuracy of Grade A in accordance with ASME B40.100. Calibrate gauges in kPa psi in not more than 10 kPa 2 psi increments from 0 to 350 kPa 0 to 50 psi in excess of the normal operating pressure at the tank. Provide level (float) switches that are mechanically actuated with Form C contacts. Include a sending unit in all electronic level sensing devices that transmits an analog or discrete signal, as required for the application, to an associated control panel or control device. Provide level monitoring/control sensors [where indicated on drawings] [_____]. Locate sensors in a location to be easily removable without interrupting service. Connect analog level sensors 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.

2.2.9.5 Control System

****

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]. Ensure all alarms and/or shutdowns consist of both visible alarm lights and audible alarm signals on either the main control panel, or on a remote microprocessor controller screen. Ensure the alarms and shutdowns function through a first-out-sequence annunciation. Provide alarms for high and low water and chemical levels, high and low pH values, and high and low ORP values. Provide automatic shutdowns 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. Ensure power failures and equipment failures initiate an alarm as well as an orderly and automatic shutdown of the treatment system. [Provide for auto-dialing to an indicated remote location 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.] Provide all control power transformers, relays, adjustable timers, auxiliary contacts, switches, or additional equipment required to interconnect the treatment equipment to a monitoring/control system. Furnish conduit and wiring between control panels, treatment components, and all control devices.

2.2.9.6 Control Panel Enclosures

Ensure all required control panels for the control system are rated NEMA 4X [fiberglass] [stainless steel] and are 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, install all instrument transmitters in or adjacent to the control panel enclosure.

2.2.10 Structural Skids

Where a P/C/F system has structural skids, supply skids 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. Show standard welding symbols on the drawings in accordance with AWS A2.4.

2.2.11 Paint/Coatings

****

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

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

2.2.12 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.

2.2.13 Nameplates

Provide a nameplate on each major item of equipment that includes the manufacturer's name, address, type or style, model or serial number, and catalog number. Secure nameplate to the item of equipment.

2.2.14 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration and maintenance of the equipment, as recommended by the manufacturer. Provide a list of special tools including description, manufacturer, model number, and a source for purchasing replacements if lost.

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. Document the results of this pre-installation examination and submit to the Contracting Officer for review.[Contracting Officer reserves the right to also conduct this examination independently.] Based on the examination, the Contracting Officer has the right to reject damaged, defective, or deteriorated equipment. The contractor is required to correct surface damage to equipment following the manufacturer's requirements. Any costs associated with the delay caused by the rejection of equipment is understood to be borne by the Contractor. Provide all specified preconstruction submittals to the Contracting Officer.

3.2 INSTALLATION

Handle equipment with extreme care to prevent damage during placement. Install equipment, 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 includes furnishing all materials required for initial operation. Properly level, align, and anchor all equipment in place in accordance with the manufacturer's instructions. Provide supports for equipment, appurtenances, and pipes as required. Install piping runs to be straight and evenly supported. Install valves with stems horizontal or above the pipe centerline. Install flanges and unions where valve and equipment maintenance may require disassembly. Provide the P/C/F system complete and ready for operation. Ensure all plumbing work conforms to the requirements of [Section 22 00 00 PLUMBING, GENERAL PURPOSE][_____].

3.2.1 Foundations

Construct foundations for tanks, clarifier, and other equipment of reinforced concrete, except as shown or specified herein.

3.2.2 Excavating, Filling, and Grading

Perform excavation, filling, and grading work to conform to the applicable requirements of Section 31 00 00 EARTHWORK.

3.2.3 Cathodic Protection

Provide cathodic protection on steel tanks and clarifiers, conforming to Section 26 42 15 CATHODIC PROTECTION SYSTEM FOR THE INTERIOR OF STEEL WATER TANKS.

3.2.4 Welding

Perform tank welding in accordance with [Section 8 of AWWA D100] [AWWA D103] [API Std 650].

3.2.5 Erection

Perform tank erection 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.
****

Perform field painting in accordance with Sections 09 90 00 PAINTS AND COATINGS[and 09 97 02 PAINTING: HYDRAULIC STRUCTURES]. Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

3.2.7 Inspections and Testing

Inspect and test tank in accordance with Section 11 of AWWA D100. Mill and shop inspections [are not required] [are required to be performed by an approved commercial inspection agency]. Contractor is required to perform the hydrostatic test. Perform final hydrostatic test before painting.

3.2.8 Radiographic Inspection and Testing

Perform tank radiographic inspection and testing of tanks in accordance with Section 11 of AWWA D100. Radiographic inspections [are not required] [are required to be performed by an approved commercial inspection agency]. Perform all testing 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 the Contracting Officer inspects to verify that the components of the system are properly installed according to drawings and specifications. Correction of all discrepancies found and work affected by such deficiencies is wholly at the Contractor's expense.

3.3.2 Tests

Ensure each piece of equipment is subject to an operational test, under the supervision of a factory representative. The Contracting Officer maintains the right to observe test. Tests are required to 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. Perform a running field test on all equipment in the presence of the Contracting Officer for a minimum of [2] [_____] hours. If any deficiencies are revealed during the tests, correct such deficiencies and repeat the tests. 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. Identify all test methods used and record all test results. Indicate within each test report the final set point of each control device. Provide test reports 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

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative is required to supervise the installation, adjustment, and testing of the equipment. Include up to [5] [7] [10] [_____] days of service.

3.4 SYSTEM STARTUP

****
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.
****

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, test all tanks for leaks or damage in shipment. Test the tanks hydrostatically [to [_____] kPa psig] [as indicated in the schedule] or 1.5 times the system operating pressure, whichever is greater. Test the tanks for a period of [24] [_____] hours. Furnish testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, and all labor required. Repair all damage or leaks in tanks or replace tanks at the Contractors expense. Test the joints of air lines 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.
****

Ensure the following items subjected to the pre-startup checkout:

a. Check foundations to verify that they are placed and sealed properly;

b. Check system to verify that all equipment has been properly installed and connected;

c. Check rotating equipment which requires lubrication to ensure that manufacturer's procedures have been followed;

d. Level and check all equipment for proper alignment, anchored, and static ground wires installed;

e. Check piping, flange bolts, gaskets, and hoses to ensure that connections are tight, and flushed clean;

f. Check valves for position and operability and flushed clean;

g. Check electrical wiring and lighting to verify that wiring has been completed correctly;

h. Perform continuity checks on wiring loops;

i. Check High/Low liquid level alarms on tanks, as well as pump on/off level controls, for proper installation and response;

j. Check chemical feed systems for proper installation;

k. Check chemicals for proper type, required quantity and mixing; fill tanks;

l. Check lockout devices and site security devices 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.

****

Subject each component of the system to the pre-startup testing as described below:

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

b. Test electrical wiring to verify that there is no wiring damage or deterioration that could cause injury to personnel or damage to equipment;

c. Turn power on to test equipment and control systems only after the electrical systems are tested and certified ready for operation;

d. Test lighting and put in service to support work in all areas of the plant;

e. Test rotating equipment such as pumps, mixers, and blowers, if used, for correct direction of rotation by bumping the starter manually;

f. Operate each pump for a minimum of [4] [_____] continual hours at operating or test conditions. Ensure 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. Fill all tanks and empty to determine if high and low level alarms sound at the prescribed liquid level;

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

i. Label and test each emergency shutoff switch to determine that it works properly;

j. Test electrical "lockout" devices with padlocks to ensure that power has been disconnected;

k. Calibrate instrumentation before systems are put into service. Test all pressure and temperature gauges against standardized gauges. Utilize NIST SP 250 calibration standards where they exist.

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.

****

Do not initiate startup 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, perform a functional performance test 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. 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. Before system acceptance, the Contractor is required to correct any deficiencies and complete all performance checks. Replace or upgrade equipment not capable of performing as specified 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. Ensure these field instructions cover all the items contained in the operation and maintenance instructions. Provide training for a total period of [8] [16] [_____] hours per day for a period of [5] [_____] days of normal working time and start after the system is functionally complete but prior to final acceptance tests. Ensure field instructions cover the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Prepare a video tape of the field training course as a permanent record for future training use.

3.4.6 Operation and Maintenance Manual Updates

****

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.

****

Include the following items in the O&M manual::

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, the contract is required to provide a maintenance schedule. Include the following items in the maintenance schedule:

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.

Record the entire schedule and the results of each task for future analysis. Include other items 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 is contingent upon these documents being supplied, reviewed, and approved by the Contracting Officer.

3.4.7 System Operation by Contractor

Do not initiate the first period of operation 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.

-- End of Section --